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10

PRACTICAL HINTS

ON

PHOTOGRAPHY:

Its Chemistry and its Manipulations.

BY

J. B. HOCKIN.

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PHOTOGRAPHY

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J. B. HOOKER

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P R E F A C E .

Having exhausted three Editions of my "Practical Hints," consisting of four thousand copies, and finding still a demand for more, I was determined to commence writing a Fourth Edition; but, learning on enquiry that a more elaborate, but not too voluminous a Manual, treating Photography more as a science and less as an art, appeared a desideratum, I was induced to considerably enlarge my scope; and the result I have now the pleasure to lay before the reader. My object has been not to make a large book, and weary my readers by collecting every possible and impossible process, but to give only such as are really practical; and I have been in a great measure guided in my choice of these by their offering themselves as types, which, their manipulation and theory being mastered, would enable the Photographer to discriminate between the utility or worthlessness of the thousand-and-one modifications which constantly make their appearance.

I have also added a chapter on the *practical* method of recovering the enormous amount of the precious metals still annually lost by the carelessness and thoughtlessness of the manipulator: compared with the quantity thus thrown away, that retained in the finished pictures is almost ridiculously small as is evinced by the analyses (page 94 et seq.).

Independently of the subjects described in the title page, a friend has kindly furnished me with some chapters upon the Optics of Photography, which are entirely original, and which appear of sufficient importance to warrant my affording them a place in a work which *professedly* treats only of the Science and its Chemistry.

J. B. HOCKIN.

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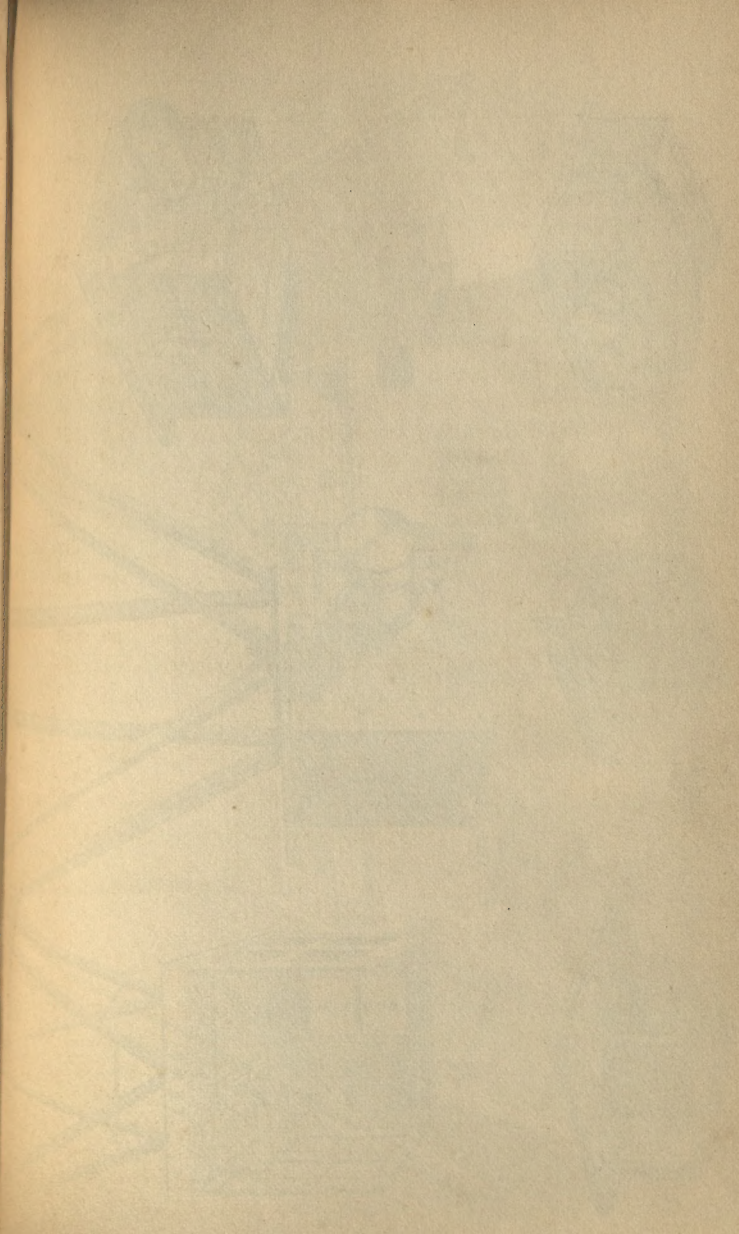
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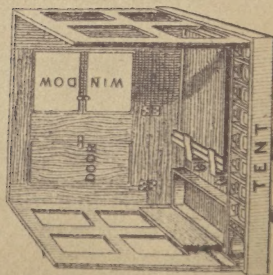
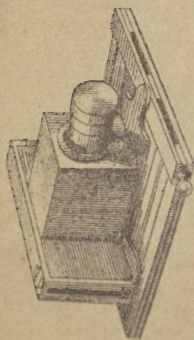
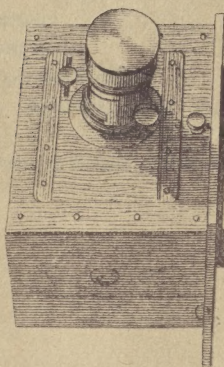
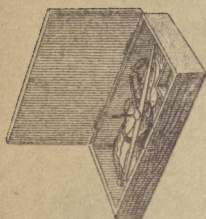
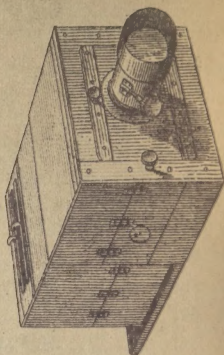
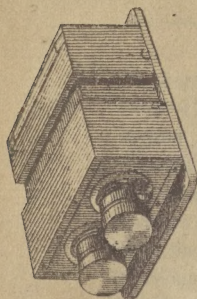
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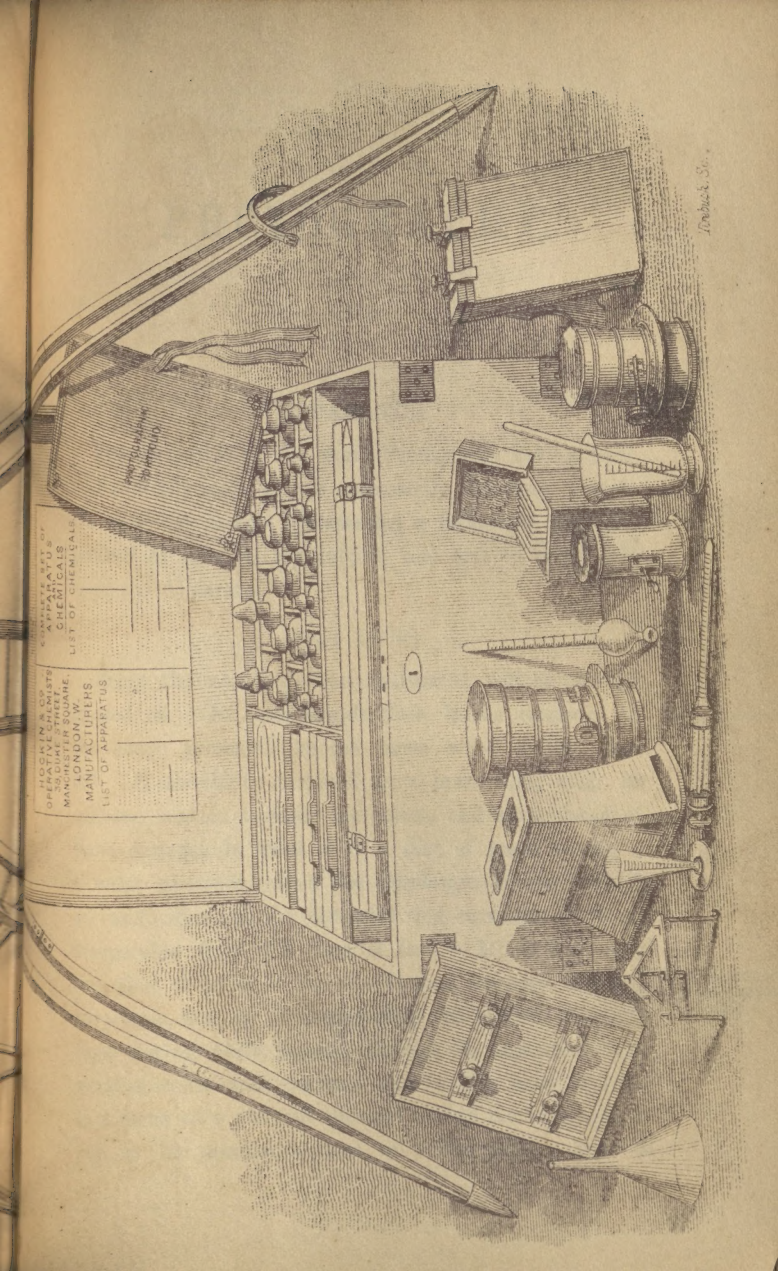


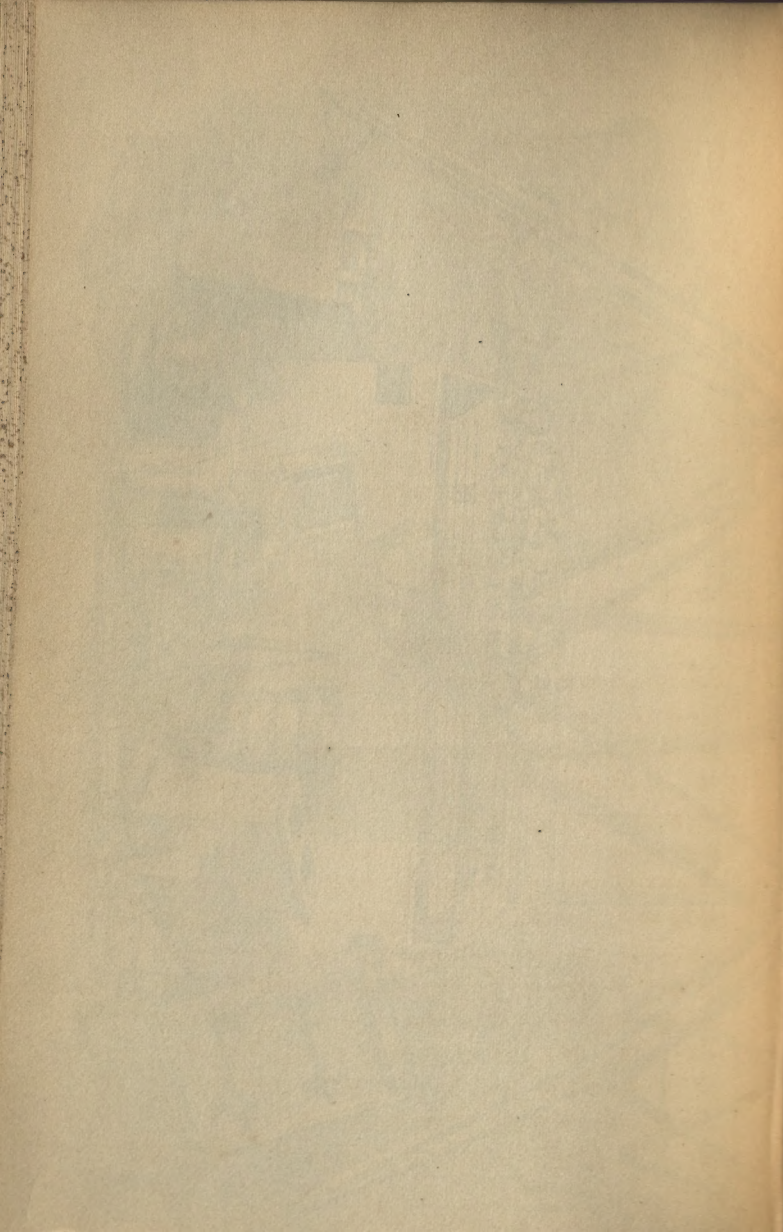
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PHOTOGRAPHY.

APPARATUS.

The derivation of the word Photography having been so frequently more or less successfully discussed, I shall not delay my readers by repeating a thrice-told tale, but proceed at once to my subject, and first in order will come the Apparatus.

THE LENS

Being the most important instrument, will be the first treated of. Its most simple form is the meniscus, or the shape presented by the moon when a few days old. It should be mounted in a brass tube, with its concave surface towards the object, and have, placed at some distance in front of it, a disc of metal having a circular aperture, called the *diaphragm or stop*, which serves to diminish the distortion and curvature of image, inseparable from this form of lens. If made of only one kind of glass it has the further infirmity of being *chromatic*, that is, of decomposing the incident luminous rays during their passage through it, separating their various constituent portions, and causing each to come to a focus at a different distance behind the lens, according to its peculiar amount of refrangibility. Now as

Meniscus Lens

is "chromatic,"
i. e. decomposes
light.

And causes separation of the luminous and "actinic" rays.

The actinic ray is the more refrangible.

the *actinic* portion of a ray, or that which most powerfully effects what we desire to produce in photography (although itself invisible) lies at one end of the spectrum, and the luminous portion *nearly* at the other, it is evident that the plane occupied by the *visible* image, projected by such a lens, will not be the place where we are to seek for the chemical ray which is to perform the changes we desire to bring about. The latter is nearer the ground-glass or "focussing screen" of the camera.

If all objects were at an uniform distance, this defect would be unimportant, as the Camera (to be presently described) might be adjusted there for once for all.

But as there is infinite variety in the distances of objects, and by consequence in the corrections for each, we need to possess an

ACHROMATIC LENS,

That is one in which the above defect has been corrected by means of a combination of two descriptions of glass, whose "*refractive indices*" are different, worked up into two dis-similar lenses, and in one of which the greatest mass of glass lies towards the *periphery*, in the other, is at the centre or *axis*; these are cemented together in close apposition, and thus form a short cylinder, having a greater or less convexity at one end, and a very slight concavity at the other, which is that looking towards the object. This form, as well as the former, requires "*stops*" for its efficient working, hence is suited only for copying objects of still life, where time is not an important element, inasmuch as the exposure necessitated *increases* in an equal ratio with the *diminution* of the apertures in the diaphragms.

Consists of two lenses cemented together.

Requires stops or diaphragms.

For portraiture and taking living and moving objects we require the

DOUBLE ACHROMATIC LENS,

Which consists, first, of a combination identical with that above described, but having its *convex* surface exposed to the object, and which is placed at one end of the brass tube; while, at the other end, and at some distance, is placed another combination, consisting of a concavo-convex of flint glass (having the latter surface forward), separated by a ring from a double convex of crown, whose greater convexity looks forward. If this latter arrangement be well remembered, it will save many from innumerable failures occasioned by the misplacing of the lenses after their having been taken out of their cell to be wiped; an accident that by no means unfrequently happens to the uninitiated. Midway between the two combinations should be a fixed diaphragm, having an aperture whose diameter is not much less than that of the lenses; it serves to cut off the flare or false light reflected from the tube of the lens, and also serves as a support for the system of stops, advocated by Mr. Whitehouse, to be presently described.

Arrangement of glasses therein.

Fixed central diaphragm.

The tube in which the "single" or the "double lens" is mounted, is generally fitted with a rack work, and slides light tight into another tube (called the "jacket,") to which is attached a "pinion" or wheel, which, by means of a milled head, serves to move the lens to and from during the focussing, and thus enables the operator to attain great precision in that most important operation.

Rack and pinion movement to facilitate focussing

Single lenses are generally designated by their diameters, thus, a $1\frac{3}{4}$, $2\frac{1}{2}$, $3\frac{1}{4}$ inch lens, &c.

Technical designation of lenses.

Double lenses, of similar diameters, are technically known as quarter, half, or whole plate, being the surface they are intended to cover, viz.: $4\frac{1}{4} \times 3\frac{1}{4}$ inches, $6\frac{1}{2} \times 4\frac{3}{4}$, and $8\frac{1}{2} \times 6\frac{1}{2}$ respectively. The reason that these shapes are quoted oblong instead of square, is that the lens illumines a circular space, and these are the largest rectangular figures that can be inscribed in such a circle, it being the diagonal, not the side of the square which is to be considered ; neither must exceed the diameter of the circle.

Reason why pictures are generally oblong.

Front lens of the double combination adapted for landscape.

The front lens of the half-plate, double combination, may be used alone for taking landscapes 9×7 inches ; that of the quarter size up to 6×5 .

To adapt it for this purpose it is so fitted into a sliding tube that it may be easily slipped out of its mounting, inverted and replaced with a diaphragm in front of it, and a tube, lined with velvet, at the back, to cut off the rays of light which would otherwise be reflected from the interior of the mounting. The back combination is here discarded altogether.

But not when the size exceeds the half plate.

The front lens of the whole plate, double combination, being of very long focus, is practically useless for landscape purposes, hence we must here make an extra lens, having a focus adapted for pictures up to 11×9 , or at most to 12×10 inches.

How to calculate what sized picture a lens will produce.

I may mention that two-thirds the focus of any lens, measured from the back of the single, and midway between the two combinations of the double, to the focussing screen, will, for all practical purposes, give a sufficient approximation to the longest side of the oblong picture capable of being produced by that lens.

Besides the above ordinary forms of lenses, there are

several others for which their discoverers or manufacturers claim peculiar merits, but I do not think it necessary to particularize them, as at present only one appears to have taken any hold upon the mass of photographers ; this is known as the

ORTHOSCOPIC LENS OF PETZVAL,

And for certain purposes appears to possess real advantages.

It produces less distortion than the ordinary view lens, and, with an equivalent focus, yields a larger picture, with extremely straight marginal lines, hence is most valuable for architectural subjects, and copying pictures, but being a double combination is much higher in price and slower in action.

Its peculiar properties.

It owes its principal peculiarities to the form of the back combination, which consists of a double concave lens and a meniscus touching only at their edges ; it cannot be worked without a stop placed *behind* the back or between the two combinations. This form, as well as the ordinary portrait combination, we owe to the calculations of Professor Petzval, who, however, appears to have gained more honor than profit by his painstaking.

Wherein it differs in form from other lenses.

I will now return to the subject of the

STOP OR DIAPHRAGM.

This, as before remarked, is a disc having a central aperture, which is used for the purpose of diminishing the amount of distortion, more or less incidental to all lenses, and producing greater flatness of field ; that is, in other words, correcting on the one hand the tendency to yield curved copies of straight lines, and, on the other, to

project an image more approaching a plane than a figure resembling a watch glass.

Essential to the single lens.

They are *always* used with the single combination placed some distance in front, the size being determined by the relative greater or lesser distance between the various perspective planes of which the view consists; thus, to obtain an immediate foreground and considerable distance in proper perspective, and with due *sharpness*, the smallest stop must be used. The most useful sizes are the $\frac{1}{2}$ inch, the $\frac{3}{8}$ inch, and the $\frac{1}{4}$ inch.

On regulation of aperture of stop.

Use of stop with double combination.

When the *double combination* is used for portraiture, the light seldom admits of the employment of a stop; the sitter must consequently bring the principal features of his body into the same plane, as all that are nearer the lens than this plane are exaggerated, those more remote diminished, both appearing *out of focus*, and with indistinct outlines. If, however, abundant light admits of the employment of a diaphragm, all this may be remedied. Its proper place is immediately in front of the double combination, as here it produces the greatest flatness of field, at the same time *diminishing its extent*, therefore the majority of operators place the stop midway between the two combinations, and thereby obtain a nearly equal flatness of field, combined with an actually greater surface covered, and only one-half the retardation. Mr. Whitehouse, before alluded to, was, I believe, the first to devise means for introducing the stops between the two combinations, *after* the lens had been focussed, thereby greatly facilitating this latter operation, which is by no means an easy one when the light is diminished by the use of a $\frac{3}{8}$ inch stop, put in situation before focussing.

Its position.

Whitehouse stops.

The following is the rule for ascertaining the retardation caused by using a diaphragm when the time of exposure with the full aperture of the double lens is known, viz.: it is *inversely* as the *squares* of their respective *diameters*, when the stop is placed in front of the double lens ; half this when placed between the two combinations ; and twice the time when used with the single lens.

Rule for finding increment of exposure with a given stop.

THE CAMERA

Is essentially a box blackened internally, having in front an aperture sufficiently large to admit the tube of the lens and allow of its free movement, and furnished at the back with grooves wherein slide the "focussing glass" and the "dark slide;" the latter, in its turn, is provided with frames or "carriers," with apertures corresponding to the various sized plates desired to be used ; or it is constructed to hold two pieces of sensitive paper, according to whether the glass or paper process be followed.

Its dark slide.

Black frames.

It is very important that this instrument be manufactured with extreme care, of thoroughly seasoned wood (none is preferable to mahogany) ; that the interior present a perfectly dull black surface, free from any bright or metallic spot whence the light may be reflected on to the prepared plate.

Its various joints should be well dovetailed where this is admissible, and *always* screwed together with brass screws ; this being the only safeguard against the deteriorating influence of alternate heat and moisture upon glued surfaces.

Every care must be taken that the ground surface of the focus glass and the sensitive surface of the prepared plate (when the latter is placed in the slide) occupy

Surface of ground glass and of prepared plate must coincide.

exactly the same plane ; as, if they do not, it is evident that the picture obtained will never be equal to that which appeared on the focus glass.

It may be well to explain the method of verifying this, as the best constructed cameras have some small tendency to lose this strict coincidence, and the cheaper ones seldom or never possess it.

Mode of gauging
dark slide and
focus glass.

Procure a piece of hard wood, one inch wide, $\frac{3}{8}$ inch thick ; long enough to stretch across the frame of the focus glass, and sufficiently *squared off* to stand thereon, without being held. Now cut a piece of card, about two inches long, into a wedge shape, and graduate one edge into sixteenths of an inch throughout its length ; place the focussing glass, with its ground surface upward, and the dark slide, having a plate in it, side by side, on a level table ; stretch the above straight edge across the focus glass, and pass along under it the wedge-shaped card, with one edge touching the ground glass, until one of its graduations comes into contact with the ruler, when you note the number reached : repeat the operation upon the glass in the slide ; if the distances differ, the remedy will be obvious.

Sliding or ad-
justing front to
camera.

For landscape purposes it is necessary that there be a means of imparting to the whole body of the lens, both a vertical and horizontal movement, in order that the operator may be enabled, on the one hand, to take more of the summits of tall buildings than he otherwise could, without “cocking” the camera, or to get rid of a mass of foreground, the presence of which would spoil his picture ; on the other hand, the horizontal movement is very useful in cities, where it may be desirable to take

one side of a vista, without at the same time including the other.

These objects are effected by making to the Camera two false fronts, capable of sliding freely, the one on the other, without, at the same time, allowing the light to insinuate itself between them. The professional or artistic photographer should furnish his camera with what is termed a "swinging back," which is an arrangement for enabling him to arrange his plate in the plane best suited to obtain the largest portion of his sitter in good focus, without troubling the latter too much to conform himself to the plane of the operator's focus glass.

Swinging back.

Decidedly the best form of camera for pictures not exceeding 9×7 inches, is that known as the

SLIDING BODY CAMERA.

It consists of a front portion (which carries the lens) attached to a "Base board," and a another body carrying the focus glass, &c., sliding within it, which being drawn out, telescope fashion, enables us exactly to double the original length of the instrument, thereby admitting the use of lenses of different lengths of focus, or the employment of the double combination lens and the single lens adapted for landscape, as described in page 4. For very large pictures, 12×10 inches and upwards, it is desirable to reduce the size of the camera when travelling; this is effected in the

SLIDING AND FOLDING CAMERA,

Being the above modified, by making the front removeable, and hingeing the sides of the inner and outer bodies in such a manner, that, when not supported by the front,

they collapse and fall down, so as to occupy not more than two inches of vertical space, instead of their former large dimensions.

These can only be made by very first-class workmen, consequently are somewhat expensive, and must not be subject to rough usage.

Bellows Camera.

There is a form known as the Bellows Camera, consisting of a base board, a front body of only a few inches in depth, and a support for the focussing glass and slide of similar dimensions, connected together by a leather sac folding, after the manner of the accordion. This admits of lenses of any focus being used, and may be made exceedingly light and portable, but it wants rigidity—the dark slide being supported only at its base vibrates with every breeze, and necessitates the employment of adventitious struts and supports, all which involves loss of time and complications.

Somewhat un-
steady.

But suited for
very large appa-
ratus.

This no doubt would be the best form for such monster apparatus as are intended to take pictures over 30 inches in dimensions.

There is a very elegant form of it wherein the base-board, hinged in two places, folds up and entirely covers the focussing glass and dark slide, containing two prepared papers or dry plates.

CAMERAS FOR TAKING STEREOSCOPIC PICTURES

Have assumed an almost infinite variety of shapes, each claiming some peculiar merit, whether for lightness and portability, or for completeness. In the latter virtue none is exceeded by a form of "Tourist's Camera," which is furnished with a box for holding any desired number of

With dark box
for dry plates
obviates using a
tent

prepared dry plates, the transferring of which to the camera for exposure is effected without *any kind of shelter* whatever, and attended with the least possible trouble ; but without diagrams it would be impossible for me to attempt to explain the *modus operandi*.

There is the *One-Lens Camera*, on a principle first enunciated by Mr. Latimer Clark, where the two pictures are taken on one glass ; but allowance is made for the lateral separation of the stations whence each is taken—the camera being made to point towards the same object from each station. Doubtless this is the best form for distant views, where near objects are not introduced and where there are no moving figures.

It also admits of the pictures being taken, the right-hand view on the left-hand side of the glass, and *vice versa*, so that when reversed, as they are in printing, they occupy each its appropriate eye when viewed in the stereoscope.

The *Twin-Lens Stereoscopic Camera* is best suited for objects at small distances, where figures are likely to be introduced ; and is absolutely essential for portraiture ; also, where *instantaneous* views are required. Much doubt has been expressed as to whether these latter are *bona fide* possible ; I answer, confidently, that they are always obtainable, provided there be sufficient light, moderate distance, and an appropriate aperture, combined with double lenses of moderate lengths of focus, and supplied with an apparatus capable of being opened and shut in a minute fraction of a second ; and of producing perfectly equable illumination of the field. I believe I am the first and only person who has realised the manufacture of such an instrument.

Monocular stereoscopic camera of Latimer Clark

Binocular or Twin-Lens Camera.

Apparatus for instantaneous pictures.

It can be applied to any lens or pair of lenses without altering their construction or interfering with their being used for other purposes ; its velocity of movement can be regulated to any degree of nicety ; it allows the light to fall, first on the axis of the lens, and in closing it lingers there last ; during the whole time the aperture maintains the same geometrical figure, through the centre of which the axis of the lens, being prolonged, would pass.

Various cameras have been contrived wherein to prepare and develop the collodion plate ; but none appear to have entirely satisfied the wants of the public.

SUNDRY FORMS OF TENT

Have also been devised ; and, no doubt, for foreign travelling, and where shelter is not readily attainable, a good-sized tent is the best "operating room." Where portability and ease of manipulation are the principal desiderata, I know nothing better than a dark box, which I have frequently manufactured, but which I cannot claim as entirely original. It consists of a tray about $24 \times 18 \times 4$ inches, supported by means of a tripod stand, and having, at each side a light frame attached by hinges ; and, in the front (also hinged), a door and yellow glass window. The sides, top and back, are covered with a material impermeable to light, and which affords means for the free ingress and egress of the upper half of the photographer, and admits of his working in a most unconstrained position, with every *facility for ventilation*, a most important question. When folded, it occupies very little more than the above space, and is exceedingly light.

It contains the bath and all the chemicals necessary for producing one dozen collodion pictures, 12×10 inches.

Light and portable substitute for a tent.

Provides for ventilation

Next in order to the camera, among the apparatus, comes the stand; of these

THE TRIPOD

Is the favorite, combining, as it may perfect rigidity, with infinite mobility. The best form has each of its three legs composed of two pieces of ash-wood, joined at the bottom (which is armed with a pointed ferrule) whence they diverge until they reach the brass triangle on which the camera rests, and projections on which *take into* holes at the top of each half leg; they are kept from collapsing by means of a stretcher or "strut," placed a little more than half way up the leg, and are thus made to resemble a very elongated letter A, inverted. The legs may be made to fold or not to suit the convenience of the photograp^{er}.

For the operating room of the professional, a more complicated machine, but occupying less space, is required; but it need not be here explained.

THE BATH,

For containing the nitrate of silver solution, is a very important piece of apparatus; indubitably, glass is the best material out of which it can be constructed; but there are many difficulties to be contended with. Above the size adapted for plates $8\frac{1}{2} \times 6\frac{1}{2}$, it is difficult to manufacture them all in one piece—i. e. blown like a bottle—they are consequently expensive and very liable to be broken, either by the plate falling off the dipper and *through* the bottom of the bath, or by the dipper itself falling to the side after being released from the plate.

Built Baths not
trustworthy

Vertical baths, built up of several pieces of plate-glass, are not to be depended upon, unless very closely watched ; I speak from considerable experience in this matter.

Archer's Bath.

I have manufactured great numbers on the principle advocated by the late Mr. Archer. They were V-shaped baths, of patent plate-glass, about $\frac{1}{8}$ inch wide at the bottom, and not more than $\frac{1}{2}$ inch at the top ; they were inserted bodily in the dark slide in such a manner that the front was placed vertically, with its interior surface corresponding with the ground surface of the focus glass ; they were intended to be used for interiors, or where great length of exposure might be necessary. The collodionized plate having been immersed and allowed to sensitize for the required time, was then made to attach itself to the front glass ; and, thus cut off from the action of the silver, it might be exposed for any length of time to the image, without fear of drying or decomposition.

Earthenware
baths not re-
commended.

Neither are the so-called *porcelain* baths to be recommended. Being highly porous, should any of the developing or fixing solutions be accidentally spilled into them, it is almost impossible to wash them out so thoroughly as to prevent the next bath put into them from being spoiled also. Much has been said both in favour of and against gutta percha, and with much justice, as, no doubt, many baths have been spoiled by a bad article in gutta. If the bath be manufactured of the best *sheet* gutta percha, I am convinced that, not only will no evil results happen, but that in it will be found to reside the greatest *ensemble* of good properties. I would recommend no one to purchase a bath made of *pressed* or *moulded* material ; if not adulterated, it is most likely to be com-

Gutta percha
baths.

Moulded fre-
quently inferior.

posed, in great measure, of old straps and pieces containing any amount of material calculated to exert an injurious action on such a delicate substance as nitrate of silver. A gutta percha bath should not be over neat in its external appearance, as this indicates great facility in parting at the seams; these latter should be always well lapped over, both at the sides and at the bottom. It is very easy to convert these into a closed vessel to contain the liquid while travelling; but I do not recommend them to be so used when travelling long distances, as, without exceeding care in fastening them down, leakage is inevitable, and very often incalculable mischief to surrounding objects is the result; nitrate of silver being corrosive of almost every article with which it may come in contact.

Water-tight for
travellers.

Glass baths, fitted into a wood case, with an India rubber-lined cover, fastened down with screws, form very neat "tight-top travelling baths," but they are equally liable to the above infirmity of leakage, and more liable to fracture from a blow or rough usage.

Glass baths fitted
as above.

Among the minor apparatus may be mentioned the "dipper" used for immersing the plates in the silver bath. These may be of silver, silver wire, or gutta percha, but are most generally made of a strip of patent plate glass, having a small strip, about three-eighths of an inch wide and a quarter of an inch thick, cemented on at the bottom. As these latter occasionally require repairing, I will explain how it is done. Clean the parts which have been in contact; heat each in a spirit lamp flame; coat with *marine glue*, or sealing wax, applied to the hot surfaces, then press very closely and retain in apposition until cold; finally trim off any superabundant cement.

Dippers.

Of glass to re-
pair.

THE LEVELLING STAND

Consists of a brass triangle pierced with holes, through which pass three brass screws with sharp points, and having three legs situated at the angles. It is employed to support the plate in a perfectly level position during the development of the picture, and thus relieve the hands of the operator of a great deal of dirty work ; which also becomes very heavy work when the plates are large.

THE PNEUMATIC PLATE HOLDER

Enables one to *cover* the plate *entirely* with collodion, which could not be done if it were held, as is usually the case, at one corner by means of the thumb and finger ; sometimes this may be important. Many use the plate holder instead of the level stand while developing ; but this is a reprehensible system, as, unless great care be exercised, one is apt to use it indiscriminately for coating the plate and developing, and thus contaminate the bath by introducing into it some of the fluid used in the latter operation.

I know of *no remedy* for this accident should it occur.

Sundry apparatus.

Besides the above, all the apparatus necessary for the prosecution of the collodion process, being that of which I shall first treat, consists in a set of scales and weights, some graduated measures, stirring rods, glass stoppered bottles, funnels, and glasses of patent plate, cut to size ; not forgetting a few soft clean cloths, washed without soap, and a chamois leather, freed from the chemicals employed in its preparation, and carefully protected from contact with grease and moisture.

CHEMICALS.

Of these, the most important in every respect, is the collodion, a liquid produced by dissolving in alcoholic ether the substance described below, called pyroxyline, being a congener of, or modified gun-cotton.

The following formula is, in my experience, the best calculated to produce good negative collodion, which differs in many important respects from that required for positives.

FORMULA FOR PYROXYLINE.

For making negative collodion :—

Negative pyroxy-
line.

Nitric acid, specific gravity 1.425	-	-	5½ fluid oz.
Colorless commercial sulphuric acid	-	-	10 "
Water	-	-	1½ "
Fine carded cotton	-	-	½ ounce.

Heat a large Wedgwood mortar by filling it with boiling water, empty the latter, dry the mortar, and remove it to a position where the fumes of the acids may be conducted away from the face of the operator, and from coming in contact with metallic or other furniture, which they are calculated to injure.

First, mix the acids gradually, stirring them with a glass rod ; then pour in the water very carefully to avoid splashes, and test the heat by means of a thermometer with a naked bulb ; the temperature will be about 130 degrees Fahrenheit ; if it be above this heat, it must be allowed to cool down thereto ; if below, a portion must be transferred to a German glass flask, and heated sufficiently by means of a spirit lamp, to bring the remainder up to that degree. Now carefully immerse the cotton by small

How to wash and
dry pyroxyline.

portions at a time, submerging each before another is added ; cover the mortar with a sheet of glass, and let it remain ten minutes. Remove the cotton by means of a glass rod, and plunge it immediately into a large vessel of water in such a manner that it very speedily parts with what acid it may retain, to which intent extend it as much as possible as soon as it reaches the water, and keep it well agitated for five minutes ; after which the water may be poured off and replaced by a fresh quantity ; it may now be safely handled, squeezed dry, and put into a smaller vessel, through which a constant current of water is to be kept running until all traces of acid have disappeared ; this is tested by putting in close contact with the cotton a piece of *blue litmus paper* ; if this remain unaltered, (not reddened), for some minutes, the washing is complete ; it should be then well wrung out by the hands, and receive a final rinsing in rain or distilled water, containing one drachm of the strongest liquid ammonia. The best mode of drying it is to spread it out on blotting paper, supported on a clean cloth, in a warm situation, defended from any chance of coming into contact with fire, as it is very *combustible* and *somewhat* explosive.

It is explosive.

Its essential pro-
perties.

If the above formula be strictly attended to, and the directions carefully followed, the resulting pyroxyline will be found *generally* to possess all the properties required for making a very excellent negative collodion. It will be soluble to the extent of five or even six grains per ounce of alcoholized æther, and will form a fluid which runs easily over the plate, void of all glutinosity, and which dries into a perfectly transparent film, without any ridges, reticulations, or visible structure. I say *generally*, because there are so

many circumstances which may modify the result, that no one formula can be implicitly relied on ; but it must be modified occasionally to compensate for the fluctuations in the materials employed, &c. Thus, the fibre of the cotton will vary immensely in its permeability by the acids ; a very fine and delicate fibre is the best for the purpose, but a coarser may be used if a little longer immersion be given ; and a difference of .05 in the specific gravity of the fluid nitric acid will indicate that it contains about $12\frac{1}{2}$ per cent. more or less of the *real* or *solid acid*, and must be allowed for by diminishing or increasing the dose of water accordingly. The acid known as “nitros” acid by the druggists may, in many places, be the only one procurable ; this is nitric acid merely contaminated with nitrous acid, which only elevates the gravity without taking any part *pro* or *con* in the operation, and if present, the real acid must be calculated as being $2\frac{1}{2}$ per cent. less than would appear by the evidence of the hydrometer. Before mixing the bulk of the acids it is always well to experiment with a small portion and a corresponding quantity of cotton. If the latter disappears, *i.e.* dissolves, soon after being put in, it shows that the acids are too weak, and therefore that the quantity of water must be diminished. If again its fibres appear matted together when taken out of the mixture, and it tears readily in the washing, it is very likely that the resulting pyroxyline will be of the variety known as “papery,” that is, will leave a white opaque film when dried on the glass—it is therefore worthless ; the remedy will be still to diminish the dose of water ; but less diminution will be required than if it dissolved in the mixed acids.

Modification of formula.

Preliminary experiments to be made with small quantities.

“Papery” pyroxyline. py-

Glutinous py-
roxyline.

Resumé.

The reverse result would arise from the *nitric* acid being too strong. The commercial *sulphuric* acid (oil of vitriol) being so very uniform in constitution, I do not consider it necessary to take its specific gravity. The cotton in this instance will be found very little altered in its physical properties from what it was before being treated, but, when dissolved to the extent of *three grains only* per ounce of æther, it will produce a glutinous film, drying with a well-defined structure, and be useless for negatives. The remedy will be to increase the dose of water *in the ratio* of a quarter ounce at a time until the desired result is obtained. At the risk of being tedious, I will recapitulate the properties required in a perfect pyroxyline appropriate for making negative collodion. Five or six grains (perfectly dried) should dissolve readily, and with scarcely any residue, in one ounce of alcoholic æther; the resulting collodion should flow freely over a glass plate, and should, when dry, leave a film perfectly transparent and free from any markings, reticulation, or visible structure. It possesses these excellencies when it is *just on the point* of leaving the papery film above described.

PYROXYLINE FOR POSITIVE COLLODION


Positive pyroxy-
line.

May be made from the above mixture of acids heated only to a temperature of 95 degrees Fahrenheit, or the acids which have been once used for making the negative may be employed, strengthened by the addition of one ounce of nitric acid, and heated to the temperature of 95 degrees.

Three grains of this to the ounce are sufficient for the purpose intended.

ON THE MANUFACTURE OF COLLODION.

Negative Collodion.	{	Pure and dry æther - - -	12½ fluid ounces
		Spirit of wine, sp. g. .827 -	7½ do.
		Pyroxyline - - -	100 grains

Procure a perfectly clean and dry pint stoppered-bottle, put in first the alcohol, then the cotton; afterwards add the æther, and shake until dissolved, which takes place in a very few minutes. Then put it by in a cool place, out of the reach of direct daylight, until it has become perfectly bright, then pour off the clear for use. The deposition of sediment will be accelerated if the mixture be made in a bottle whose base is the widest portion, and the abstraction of the clear liquid be much facilitated by drawing it off by means of a modified syphon thus manufactured: procure a good sound cork, which will fit the bottle easily, bore two holes $\frac{1}{4}$ inch in diameter through it, and pass down one a piece of glass tubing 8 inches long, bent above the cork at a very obtuse angle; through the other pass a tube of similar diameter, bent into the form  here represented, having one limb slightly shorter than the other. It is thus used: put the longer limb of the syphon inside the bottle, just high enough not to disturb the sediment; fit the cork tight into the neck of the bottle, and blow with the mouth fixed to the 8 inch tube on to the surface of the fluid; the pressure will immediately cause it to rise in the syphon and run into any vessel placed to receive it; when this is full, cease blowing, and the collodion in the syphon will run back again into the bottle, provided the aperture of its short limb be above the level of the fluid inside; if not, exhausting the air will cause it to do so. In making large quantities, it is found necessary to decant more than once before the collodion is sufficiently bright for use.

Where to pre-
serve it.

How to facilitate
deposition.

Syphon to draw
off the clear.

How to purify
the æther.

The æther employed for this purpose should have been washed to free it from admixture with alcohol, then dried by digesting it for some time upon chloride of calcium, mixed with a little free lime to absorb or decompose that peculiar principle which causes æther, which has been long kept, or which has been preserved in a bottle, partially full, and exposed to too much light, to decompose the iodides and eliminate their iodine. It must then be re-distilled. There is now no lack of a perfectly pure and dry article in our market.

Absolute alcohol
not necessary.

I find no practical benefit resulting from the use of absolute alcohol; that prescribed above is what is known to the Excise as 60 degrees "over proof," and answers every purpose in the manufacture of collodion. If it cannot be

How to prepare
if wanted.

obtained of this strength, it will be necessary to rectify it by adding to each pint two ounces of recently dried carbonate of potash, (salt of tartar) agitating frequently for about twelve hours, then allowing the dense liquid which forms to settle, pouring off the alcohol therefrom, and distilling it; which operation, as also in the case of the æther, demands very great caution—both vapours being so highly inflammable, and under certain circumstances, explosive. The retort containing the latter must be heated by a vessel in which water is kept at a boiling temperature—the former must be immersed in salt and water, or heated by steam in a suitable vessel.

To distil alcohol
and æther.

TO IODIZE THE COLLODION FOR NEGATIVES.

Iodizer for nega-
tive collodion.

Iodide of cadmium	-	-	-	-	128 grains
Ditto ammonium	-	-	-	-	96 "
Pure æther	-	-	-	-	5 fluid ounces
Alcohol, sp. gr. .827	-	-	-	-	3 "

Dissolve, filter, and add one ounce to seven ounces of perfectly *bright* negative collodion, then set it aside for some days to allow of the deposition of the slight sediment, which almost invariably occurs. The ammonium salt should be, as nearly as possible, colourless; if not so, it may be rendered sufficiently free from colour by heating it for a short time, sparsely scattered over a China plate, serving as cover to a saucepan of water kept boiling. The cadmium salt must be absolutely colourless; almost any iodide will serve for the iodation of collodion, provided the pyroxyline be of the requisite quality, but I find that a combination of two produces the best results; it may be cadmium and potassium, cadmium and zinc, or calcium, or in fact any other possessing the necessary solubility. The cadmium salt possesses the remarkable property of retarding, or indeed obviating the tendency of iodized collodion to become coloured through the elimination of free iodine, which, after it accumulates beyond a certain extent, diminishes, and almost entirely destroys its sensitiveness. That combination of iodides is the best which allows some slight colouration to take place, but this only after the lapse of some time, and, as it were, almost imperceptibly.

Proportion of
iodizer to col-
lodion.

A mixture of
iodides prefer-
able.

Iodized collodion
should colour
very slowly.

The above proportion of iodide, viz., about $3\frac{1}{2}$ grains to the ounce of collodion is, within very narrow limits, the utmost amount admissible without producing the effect of over iodizing; in fact, for large plates the above proportions will be somewhat large, and require reducing. A negative collodion, with the due amount of iodizer should appear, when taken from the silver bath, of a

delicate primrose colour, with a slight tinge of blue ; the latter due to its partial transparency.

Over-iodized col-
lodian.

If over-iodized, all shade of blue is lost, and on being touched gently by the finger, the film of iodide may be removed from the surface of the collodian without injuring the latter ; and the picture resulting from such material will frequently come off in a similar manner on the plate being washed. Excessive over-iodation allows of the film coming off in the bath in flakes and necessitates its filtration.

By frequent use and constant evaporation, a sample of collodian, at first in excellent condition, will become thickened, and therefore over iodized. Dilution with alcoholic æther will, of course, be the remedy.

IODIZING SOLUTION FOR POSITIVES.

Positive iodizer.

Iodide of cadmium	-	-	-	-	24 grains
Iodide of potassium	-	-	-	-	21 "
Bromide of cadmium	-	-	-	-	8 "
Alcohol and æther	In the same proportion as for negatives				} 2 fluid ounces
Pure iodine	-	-	-	-	
					1 grain

Precautions to be
observed in keep-
ing iodized col-
lodian.

Add one drachm of the filtered liquid to seven drachms of positive collodian. Both this and the negative should be preserved in as cool a situation as is attainable, and away from strong daylight, which exerts a decomposing action, eliminating iodine ; a property, however, which may sometimes be turned to advantage, viz., in the case where the photographer, at a distance from his laboratory, finds his collodian has become colourless, and fogs, and that he has left his tincture of iodine bottle behind him.

ON THE NITRATE OF SILVER BATH.

The silver bath.

Crystallized nitrate of silver	-	-	-	10 drachms.
Distilled water	-	-	-	20 fluid ozs.
Iodized collodion	-	-	-	$\frac{1}{2}$ "

Rain water may be substituted for distilled if the latter be not procurable (as it may be in most photographic operations), but it must be boiled in a glass vessel, and cooled previously to being employed. Near the sea, what falls in the early part of a shower is almost always impregnated with salt, (chloride of sodium), hence it is well to catch the rain water after it has been raining some short time. To return to the bath. Dissolve the silver in half the water, add the collodion and shake well up; then add the remainder of the water; let it repose some time, then filter through paper. If made of rain water, which always contains some organic impurity, the bath must be exposed for an hour to direct sun-light. By this means I have succeeded in making a perfectly good and pure bath from rain water which had been stored some time in an open water cask.

Order of mixing the chemicals.

Precautions to be observed if made with rain water.

The object proposed in adding iodized collodion is, in the first instance, to saturate the liquid with iodide of silver, of which it dissolves a certain portion. This might be effected by adding an iodide direct; but it was found that a bath thus prepared did not immediately act as well as one which had been a short time in use. Since I first recommended the above method, in 1852, I have never failed in producing a bath which worked satisfactorily, provided the following directions were also attended to. The silver bath should be as nearly neutral to test-paper (blue litmus) as is possible, without being absolutely so; the

Silver bath should be nearly neutral.

excess of acid necessary being no more than about one-tenth of a drop per imperial pint (20 ounces) of liquid.

Mode of testing. This is indicated if a piece of the above paper, agitated with a considerable bulk of liquid, begin to change slightly at the edges within thirty seconds, and become distinctly altered and *inclined* towards a purple red within two minutes. A bath thus constituted communicates the highest amount of sensitiveness to the collodion film ;

Evil influence of acid baths. with a more distinctly acid reaction the quickness is much reduced, and the definition is never so perfect. It will be seldom, if ever, necessary to add any acid to a newly-made bath prepared as above. Should any be required, it must be *nitric* acid diluted by adding ten minims of the strong acid to two ounces of distilled water ; ten minims of this (equal to one-tenth minim of nitric acid) will be amply sufficient for a pint of liquid. Many have recommended

Acetic acid injurious.

the use of acetic acid ; this is an error, it is liable to produce acetate of silver, an insoluble material, which precipitates upon the pictures and produces various defects. Moreover, it does not act so readily upon the test-paper, and thus much too large a dose may be added without its presence being apparent until a picture is tried, when, notwithstanding sufficient exposure may have been given, the picture is wanting in definition and half tone, which no additional amount of exposure will produce. *Fused* nitrate of silver has been also recommended, but this is a still graver error. It is impossible to fuse this salt without producing some *nitrite*, which, although chemically speaking not alkaline, acts like an alkali in the bath ; it becomes, therefore, necessary to decompose it by the addition of a stronger acid (*nitric*), which involves a large

Fused nitrate very injurious.

amount of trouble, and causes serious inconvenience to persons not conversant with the chemistry of the subject. It was proposed by persons who, employing inferior collodions, could only by this means produce the requisite *density* in their negatives. It is not only unnecessary, but actually injurious, where a properly constituted collodion is employed. Should the bath, on being tested, speedily redden the test-paper, the nitrate employed was acid; this may be remedied by adding *ammonia* diluted as before described for nitric acid, ten minims at a time, testing with a fresh piece of paper between each addition until the above faintly acid reaction is reached.

How to remove excess of acid or alkali.

The attempt to neutralize an acid bath with carbonate of soda must necessarily fail—a fact known to every one having the most elementary knowledge of chemistry—inasmuch as the carbonic acid, disengaged by the nitric acid, itself exhibits an acid reaction which continues even after an *excess* of the carbonate has been added, and thus, although your test-paper indicates a slight amount of acid, there may actually be an excess of alkali sufficient to upset all your arrangements for working. The merest tyro in chemistry knows that in the reaction between an acid and an alkaline carbonate he is not allowed to use his test-paper until the liquid *has been boiled several minutes*. I have seen the latter alternative *gravely* propounded to the photographer by one whom no one can accuse of want of knowledge of chemistry, and can only wonder why he should persist in making first a grave chemical error, and then setting to work clumsily to rectify it. Fancy boiling down a bath consisting of a gallon or more!

Carbonated alkalis will not neutralize.

Reasons why ammonia is to be preferred.

There cannot possibly be any objection to the use of ammonia ; it is the only alkali which we can obtain in a *perfectly* pure state, and the only one which will remain so after the bottle has been once opened. Some have asserted that the salts of ammonia accumulating in the bath have a tendency to lose their ammonia and become acid. This is absurd and impossible, and needs, therefore, no refutation. Once united with nitric acid (which it becomes immediately it comes in contact with nitrate of silver, eliminating the oxide of the metal), no power there present can separate them. The well-known action of a strong heat in breaking up the compound into nitrous oxide and water will immediately occur to every one as a proof to the contrary of such an assumption.

Popular errors refuted.

Oxide of silver a bad substitute.

It has been lately recommended to employ oxide of silver for this purpose, but no better result is obtained, and, owing to its great insolubility, the manipulation is rendered much more tedious. In fact, as I endeavoured to show in the preceding paragraphs, the effect of adding ammonia is the ultimate neutralization of the liquid by oxide of silver. Independently of a right use of test-paper on making a new bath, it is equally valuable as a guide after the bath has been some time in use, the action of a high temperature or strong light upon it converting some of its components into substances possessing an acid reaction. Highly coloured collodion will, in course of time, also produce a similar effect.

Bath becomes acid by use.

Requires to be strengthened from time to time

After exciting a number of plates in a bath, it will be necessary to replenish it by the addition of a solution of silver somewhat stronger than that originally employed, inasmuch as each plate diminishes the relative quantity of

this material in the liquid. This must be effected by frequently adding (in quantities not exceeding half an ounce at a time) a solution containing 35 grains of nitrate of silver to the ounce of water. It will be remembered that we originally started with only 30 grains to the ounce.

If this rule be strictly attended to, there will be no necessity for recurring to the bath-tester or argentometer; an instrument so called, but in the form of an hydrometer, is extensively sold for this purpose, and calls for a word of explanation. Being totally unadapted to the purpose, did it give any indications they would be the reverse of true ones. It merely gives the specific gravity of the fluid, and as this is constantly varying by the accumulation of æther and alcohol on the one hand, and of one or more nitrates on the other, its indications must always be fallacious. The only method of ascertaining the amount of silver in a liquid, is by precipitating a portion thereof by means of a standard solution of a chloride dropped from a graduated burette.

Bath tester

Must not be a hydrometer.

I have devised a very neat and portable form of the latter instrument, occupying but little space, and offering great facilities for the manipulation, each numbered gradation corresponds to one grain of nitrate of silver.

Proper form tester.

A very neat modification of the process has been lately reintroduced by a well-known ingenious chemist, viz., the addition of a minute quantity of bichromate of potash to the liquid under examination. This enables the exact period of perfect saturation to be ascertained by means of the change of colour which suddenly occurs.

Modification of process.

Frequent filtration not desirable.

Many are in the habit of returning the bath into its bottle after using it, and filtering it back again the next time they intend working. I do not agree with this plan, nor indeed is it necessary, if due care is taken to protect it from the influence of the dust, always present in the atmosphere, by covering it with a cardboard cover whenever the plate is not actually being immersed in, or taken out of, the liquid. I find it also well to employ the same filter as frequently as possible, in fact, until it breaks, as every new piece of filter-paper contributes its small quota of impurity. For this purpose I keep the filter in a funnel fully large for it, covered over with a glass plate.

DEVELOPING AGENTS.

FOR NEGATIVES.

Pyrogallie Solution.	{ Pyrogallie acid	3 grains
	{ Glacial acetic acid	1 drachm
	{ Distilled water	3 ounces

FOR POSITIVES.—No. 1.

Proto-Nitrate of Iron.	{ Proto-sulphate of iron	140 grains
	{ Distilled water	8 ounces
	{ Nitrate potash, pure	102 grains
	{ Glacial acetic acid	2 drachms

No. 2.

Or, Proto-Sulphate of Iron.	{ Proto-sulphate of iron	40 grains
	{ Distilled water	4 ounces
	{ Glacial acetic acid	20 minims
	{ Nitric acid	4 minims
	{ Alcohol	$\frac{1}{2}$ ounce

The first formula for positives produces pictures of a certain warmth of tone; the second of a bright silvery appearance.

Being liable to decompose if long kept, these solutions should be made in small quantities only, sufficient for a few days' use; if at all turbid when mixed, they must be filtered through paper.

Next in order, after the nitrate bath, come the *developing agents*, a class of bodies which have a tendency to reduce soluble silver salts to the metallic condition. The liquid upon the plate, after its exposure in the camera and the action of light thereon (what that action consists in still remains an impenetrable mystery), exhibits great promptitude in being acted on by these bodies, and, if the exposure has been properly timed, the energy shown is exactly proportioned to the amount of luminous influence exerted; thus a picture is obtained whose lights and shadows are produced by a graduated deposition of *metallic silver*, which may or may not be associated with matter of an organic nature. The latter, I contend, is to be considered as accidental, and not essential to the formation of the picture, as it may be extracted by suitable solvents and the picture still remain in its integrity.

Action of developers.

Picture consists of metallic silver

I cannot agree with the theories broached by the presence of suboxides of silver, being convinced that they would be immediately dissolved by a solution of cyanide of potassium, which a picture, however delicate, successfully resists for a considerable time.

And not a suboxide.

The pyrogallic acid is the agent best adapted for producing negatives. It is produced by subjecting gallic acid to a heat somewhat exceeding 400 degrees Fahrenheit, and acts by virtue of a remarkable affinity it possesses for oxygen. We are indebted for the knowledge of its value, as we are for almost every step in the collodion process,

Pyrogallic acid for negatives.

And proto-salts
of iron for posi-
tives.

Act through
their affinity
for oxygen.

to Mr. Archer, and it is a sad reflection when we consider how little return *he* or *his* have experienced at our hands. The proto-salts of iron are also sometimes employed in the development of negatives, but unfrequently, their excessive energy being difficult to restrain within the desired limits; but they are sometimes useful when the deficient action of light, or a low temperature renders the more energetic agent necessary. Their chief use is in the development of direct positives, of which more hereafter. *They* also act by reason of their affinity for oxygen, of which the silver must be deprived ere it can be detached from the strong acid with which it is combined, and precipitated to form our picture, which would appear to result *entirely* from the decomposition of the nitrate employed. What part the iodide or bromide used takes is not readily apparent.

FIXING MATERIAL.

Cyanide solution	{	Cyanide of potassium	. . . 30 grains
		Water . . . . .	. . . 6 ozs.

The above is the best material for *fixing the proof*, i.e. dissolving out those parts which, having been unacted on by the light, would, if allowed to remain, become altered by subsequent exposure, and spoil the result previously obtained.

Many are prejudiced against this chemical on account of its being highly poisonous; but, I think, unnecessarily, as it only becomes injurious if taken into the stomach; its odour is by no means unpleasant, and not at all injurious. It is also useful in removing silver stains from the fingers and linen, and many other purposes to be hereafter described.

Another fixing material consists of water, 6 ounces ; Hypo'-fixing solution
 hyposulphite of soda, 2 ounces ; but I do not recommend
 its employment for pictures on glass ; its high density
 gives the film a great propensity to float, and if the hypo' Not recom-
 then gets between it and the glass, it is almost certain to mended.
 peel off on drying. I have known instances of large and
 valuable negatives being thus almost entirely detached
 from the glass, and which, ere they could be varnished,
 have cracked into thousands of fragments.

Great care must be taken that none of the developing
 or fixing agents find their way into the silver bath ; the
 smallest conceivable portion would irrecoverably spoil it.
 Inattention to the careful washing of the hands after
 finishing a picture, and before commencing another, has
 sometimes been known to contaminate the glass plate, and
 hence the bath, with these agents.

THE DARK ROOM.

It is indispensable, in all photographic operations, to
 have a room from which white light can be wholly ex-
 cluded. We may either entirely exclude daylight, and
 use a lamp with a yellow shade, or, which is preferable,
 cover the windows with several (three or four) folds of
 orange-coloured calico, or a sheet of India rubber, $\frac{1}{32}$ -inch
 thick ; but, perhaps, the best defence is a yellow glass
 made for the purpose, which is readily procurable ; the
 light which passes through these is entirely deprived of
 all actinic rays. I have used the India rubber in a
 camera I have constructed for developing pictures out of
 doors, with the happiest effects, never having found the
 strongest sunlight prejudice the operation. I am not,
 however, prepared to say what might be its effect if the

Mode of illumi-
nating.

exposure were long continued. I believe the photographic world is indebted to Mr. Wilkinson for this application.

The dark room should be furnished, if possible, with a sink and a plentiful supply of water ; if however these be not attainable, a jug and basin will serve instead ; common water answers all purposes after the developing has been effected.

Those who wish to employ the collodion process at a distance from habitations, will provide themselves with a dark tent, or vehicle, capable of being closed against the light, or the apparatus before described, page 12.

THE OPERATING ROOM.

The glass room
and its fittings.

The professional photographer must provide himself with a room with a glass roof, and *at least one side* of the same material, choosing in preference a northern aspect ; the glass must be covered with blinds so adjusted as to shut off or admit light, as it may be desirable. He will also provide himself with moveable back grounds, composed of canvas stretched on a frame, painted in flat gray tints, containing more or less black according to the requirements of the subject, dark figures and draperies requiring of course the lightest tones.

Portraiture in
the open air.

The amateur will most likely effect most of his portrait taking in the open air ; a yellowish blanket will form an admirable back-ground for the purpose. The sitter must be placed out of the *direct* solar rays, and, if the light be excessive, he must be screened therefrom by a brown holland, or blue shade, stretched some two feet overhead ; light-coloured materials spread near the feet will obviate the strong dark shades projected by the more prominent features. As a general rule, direct light is not necessary,

plenty of diffused light is what we require ; it is thus that we so seldom succeed in taking a good portrait, in ordinary rooms, the only light then obtainable being that coming *direct* through the window, that which is diffused losing the actinic rays from the more or less yellow tone of the walls and draperies. If the experiment be made in an ordinary room, place the sitter some feet from the window, extend a white cloth near the feet, and a white screen in such a position as to reflect a good light on the shaded side of the person ; if there be a second window, the light therefrom must be prevented from falling on the eyes of the sitter.

In an ordinary room.

The light reflected from masses of white cloud possess the largest amount of *actinic* power, that emanating from a clear blue sky comparatively little.

It is very convenient, nay, almost indispensable, to provide the "sitter" with a "head rest," as, whether sitting or standing, few people can keep themselves sufficiently still not to destroy, in some degree, the *sharpness* of the picture, by slightly moving during the comparatively long period of a minute or more, which is sometimes necessary for producing a picture.

Head rest.

MANIPULATION.

CLEANING THE PLATE

Is an operation upon the due performance of which much depends ; it is thus effected :—The plate must be well rubbed on both sides with a pledget of cotton wool or linen, tied on to the end of a piece of deal, and dipped in a strong solution of cyanide of potassium, (50 grains to the ounce of water), and the friction continued until all grease or remains of former pictures are removed. It must be then rinsed with an abundance of water, so as to wash away every particle of cyanide, and wiped dry with cloths kept for this especial purpose, when it will be ready to be stored in the “Plate Box” until required for use.

POLISHING THE PLATE

Is effected by using the following mixture, well shaken up :

Venetian Tripoli Powder	. . . . .	1 drachm
Spirits of Wine	. . . . .	2 „
Liquid Ammonia	. . . . .	$\frac{1}{2}$ „
Distilled Water	. . . . .	1 ounce

Plate cleaner.

Rest the plate on a pad of paper, or on an instrument made for this purpose ; take a small quantity of the above on a piece of cotton wool, and carefully extend it with a continuous *circular* motion and much friction over one side of the plate, and continue the operation for about a minute, taking care not to allow the tripoli to become dry ; then clean it off with a soft

cloth kept for the purpose, and carefully remove every trace of powder from the rough edges. The final polish is to be given by brisk rubbing with a warm and dry piece of chamois leather, quite free from grease. To prove that the plate is perfectly clean, breathe on it, if the appearance presented is that of an uniform bloom, it is correct; but if any spots or streaks are apparent, the operation with tripoli must be repeated. Inattention to this extreme cleanliness is a fertile source of failure. If the cyanide be not perfectly removed by the washing, its presence will be apparent on the picture by more or less large round or oval transparent marks; any streaks evident on projecting the breath upon the plate will similarly show themselves on the picture.

To test whether
the plate is clean

Much has been written upon this subject, and various acids and alkalines, and wonderful nostrums recommended, but nothing more than the above is required; and I can promise, that if the above directions be faithfully followed, my experimenting readers shall never be troubled with "dirty plates." Cyanide is the universal solvent in photography, it equally takes off grease, metallic stains, nearly all varnishes, and, in fact, every substance which is likely to occur in the practice of photography. If the plate have on it a picture which has been varnished, add some tripoli to the cyanide solution, and it will readily come off, unless it be varnished with "lacquer" or "spirit varnish." The solvent for this is *wood naphtha*, spirit of wine, or some waste collodion.

Cyanide the best
cleanser.

To clean a var-
nished plate.

COATING THE PLATE.

See that it is free from dust or visible contamination. Hold it by one corner, between the thumb and finger of

the left hand. Remove the stopper from the collodion bottle by the little finger of the same hand, and cleanse the mouth of the bottle from any dry material which there accumulates, as, falling on the plate, it would produce spots technically termed "comets." Pour on to the centre of the plate as much collodion as it will hold ; then cause it to flow successively to each corner, avoiding the thumb, finally, pour off into the bottle *at the right hand corner nearest the body*, keeping up an oscillatory motion until it ceases to drip. Replace the stopper of bottle, place the plate on the *dipper*, and proceed to immerse it in the nitrate bath *contained in the dark room*, a certain time having been duly allowed for the collodion to set. This depends so much upon temperature, &c., that no rule can be given. The appearance of the film is the only criterion, and this cannot be explained in words—it must be seen to be understood. A too hasty immersion will coagulate the moister portions, and one too tardy cause the film to be covered with markings somewhat resembling forked lightning.

Immersion in bath.

Results of immersion too soon or too late.

Further remarks on coating the plate.

Too much care cannot be exercised in coating the plate, it being by no means an easy operation, but, on the contrary, one that requires much thought and attention. The plate must be held perfectly horizontal, and have as much collodion poured on to it as it will conveniently hold ; nevertheless, this must not be allowed to stagnate for one moment, but be made as soon as possible to perform its tour of the plate, visiting each corner in succession, until it arrives at the last, whence it is returned into the bottle ; when the collodion ceases to drip, the stopper must be replaced, and fixed tight to prevent its jumping out, which is liable to occur in hot weather, from

the shock produced by setting down the bottle ; the plate, in the mean time, must be kept in the identical position in which the draining was effected, otherwise the portion still fluid would run back towards the centre, leaving an unsightly ridge known as the "Double film." The same appearance is produced if, during the coating of the plate, the collodion be allowed for one moment to remain in contact with any edge of the plate held lower than another. The pneumatic holder should be always used when large plates are coated.

Phenomena of
the "double
film."

THE IMMERSION IN THE BATH

must be done boldly and without stopping, as each rest produces a streak across the plate. After remaining fifteen seconds, move the plate up and down several times, and allow it then to repose for *two minutes*. It will be seen to have become a rich and creamy yellow, if the proper temperature of the room (at or over 60 degrees Fahrenheit) be observed. Now repeat the up and down movement somewhat violently, until the liquid flows uniformly over the surface, all trace of oily appearance being lost, and the plate is ready for transference to the *dark slide*, where it should retain the same position occupied by it on being taken from the bath, and, when there, the back should be covered with a piece of *red* blotting paper extending below the bottom edge ; this serves to absorb the drainings and prevent their saturating the slide, and finally dripping over the clothes or the apartment of the operator.

Precautions used
to keep the dark
slide dry.

If the plate be kept much longer in the bath than the above time, some portion of the sensitiveness is lost. The *excited plate* should be exposed in the camera with as

The excited plate spoiled if allowed to dry.

little delay as possible ; if it dries, it is entirely useless ; under ordinary circumstances, ten minutes is the longest time it will retain its sensitiveness. If more than five minutes elapse it will be necessary to re-dip in the silver bath ere we proceed to develope. After collodion has been used over a large plate it should be examined, to see that it has acquired no particles of dust ; if it have, it must be allowed time to settle, a fresh quantity being taken for use in the mean time. After being used for several plates the collodion will have become too thick from evaporation, it must be diluted with one-fourth or more of æther and alcohol, and allowed time to settle, fresh material being, in the mean time, used as above described.

Archer's bath.

The late Mr. F. Scott Archer, the discoverer of the application of collodion to photography, invented a means of obviating the drying of the plate during a very long exposure, such as may be required in taking pictures of dark interiors, and without loss of sensitiveness. He constructed a glass bath of V shape, the front glass of which was placed vertically in the slide, with its interior surface occupying the same relative position as the ground surface of the focus glass ; the back and sides were also of glass, cemented together with *marine glue*. When in use it was filled with the usual nitrate bath, and the prepared plate immersed in it, reclining against the back glass of the cell ; when duly excited it was moved so that its sensitive surface came into intimate contact with the vertical front of cell, and while in this position, surrounded on all sides with, yet not immersed in, the liquid, the film was allowed to receive the incident rays, without decomposition, during as long a period as they might be required to act.

PORTRAITURE.

While the plate is being prepared, an assistant may be arranging the accessories ; the background chosen being such as harmonises best, or contrasts with the dress of the "sitter," who should be placed in such a position that as much as possible of the person may lie in the same vertical plane as the face, all parts nearer the lens being exaggerated, those more remote diminished, and both "out of focus" (indistinct or hazy), unless a small diaphragm be used ; this, however, is seldom applicable, as it defeats the great object in portraiture, viz., that of obtaining the picture in the shortest possible space of time. Too great glare of light always causes an uncomfortable expression of countenance ; it becomes therefore necessary to protect the sitter from it by drawing a blue curtain horizontally over head ; and if the operating room be somewhat elevated, similar screens must be made to run along the side whence the light is obtained. The most pleasing portrait is usually the "three-quarter face," the point of sharpest focus being the eye.

Arranging the
sitter.

Small dia-
phragm seldom
used

It tends very much to artistic effect if one side of the face, the larger, be more strongly illuminated than the other. Too much vertical light is to be avoided, as it causes the more prominent features to throw very deep shadows ; these may be partially obviated by placing a light-coloured fabric near the feet.

Management of
the light.

The professional photographer must necessarily furnish himself with a glass room in which every contrivance for admitting or shutting out the light is provided, as also, backgrounds of graduated tints, and with or without a landscape or draperies depicted thereon ; he must also

have a "head rest," capable of adjustment, for a child, a sitter, or the tallest full-length.

Portraiture in
the open air.

The amateur, seldom possessing these luxuries, most likely prefers operating in the open air. He, too, must provide some kind of background; a yellowish blanket forms a very good one, provided it be not placed so near the sitter as to be in focus with him and show its grain. A screen also is necessary to cut off the superabundance of vertical light. A head-rest of very simple construction, adapted for screwing on to the back of a chair, may be purchased for a very small sum at the shops of all the dealers in photographic apparatus.

In an ordinary
room.

It is very difficult to obtain a good portrait in an ordinary room, even in the country. The best chance of success lies in finding one with a window reaching from the ceiling nearly to the floor; the sitter must be placed near this, with a white screen so situated as to reflect some light into the shaded side of the face. If there be two windows, the light from the second must not be allowed to interfere.

Too sharp a
focus sometimes
undesirable.

In many cases it may not be desirable to produce too minute a "map of the face," as, for example, when scarred with the small-pox, freckled, or patched irregularly with red; these defects, if focussed too sharply, have a tendency to become somewhat exaggerated by photography. Under these circumstances it may be best to focus *more generally*, so as to obtain a good *ensemble*, and endeavour, during the subsequent developing, to produce more density in the face than in the other portions of the negative, so that, when printed, it may be comparatively white.

ON THE DRESS OF THE SITTER.

Owing to the colors reflecting more of the actinic rays the nearer they approach the violet of the spectrum, it follows that we must not always expect to produce a perfectly faithful transcript of their optical effect. Rich yellows and reds, which are *light* colours, having a great tendency to come out somewhat dark, and on the contrary, *dark* blues and violet to come out more or less nearly white. The material of which the dress is composed is not very important, silks, stuffs, and broad cloth, all photographing well; there is, however, one grand exception—that most beautiful of all fabrics, velvet, absorbs nearly all the light incident upon it, except at a certain angle, and, consequently, is seldom produced in its integrity in a photograph.

Photographic effect of colours not exactly the optical.

Velvet a difficult material.

GROUPS

Should be arranged as much as possible along the arc of a circle which would be formed by a string attached to the lens, and led off to the distance where the figures are forming; but this arrangement should be done artistically, and in such a manner as to avoid the appearance of too great mathematical precision, which produces stiffness of effect. Wherever the light allows it, a stop should be used, as it admits of much more natural grouping. In this case, as in that of portraiture, where artistic effect is aimed at, the “swinging back” proves of great value, enabling us to suit the camera to the principal plane of the object, and not *vice versa*, as before remarked.

How to arrange.

A stop desirable.

The preliminaries being settled, and the plate ready in the slide, the operator proceeds to

THE FOCUSSING,

which is thus effected :

Focussing with
double lens.

Use of focussing
cloth.

Shade for lens.

Focussing with
full aperture, or
large stop.

With very small
stop.

Difficulties of.

Means of obviat-
ing these

Draw out the *sliding body* of the camera until the picture becomes tolerably distinct, and retain it in this position by means of a clamp screw there for the purpose ; then, with the head covered with the focussing cloth to cut off all light but that transmitted by the lens, proceed to the perfect adjustment, through the aid of the rack and pinion movement. It is necessary, when the light is at all strong, to provide against its falling upon the lens, and thereby interfering with the comparatively weaker light emitted from the object ; this is effected by means of a dark coloured paper cone extending the requisite distance beyond the lens, or by a black screen placed in a horizontal plane above it.

The foregoing remarks apply more particularly to focussing with the full aperture, or with a stop not less than seven-eighths of an inch, when the light is not very visibly diminished, and, consequently, the sharpest focus not very difficult to see when obtained.

In landscape it is necessary to employ the smallest stops, never exceeding a half inch, and most generally three-eighths or even a quarter inch, owing to the great disparity between the front and remote planes, (near and distant objects), hence the light is diminished to a very small amount, and the sharpest focus very difficult to see when obtained, inasmuch as the half-inch stop diminishes the light *four times as much* as the inch, the quarter inch, *sixteen times*.

The following mode of proceeding obviates all difficulties attendant on the use of a small stop, and produces

altogether a more harmonious landscape than would otherwise result.

Trace on the centre of the focus glass a circle nearly equal to the aperture of the lens : focus, using the three-quarter inch stop, upon the periphery of this circle, and put in the smaller stop before taking the view.

It is essential to all fine focussing to oil the ground surface of the focus glass, and to use a magnifier of not too high a power; none are better than the lenses used by the watchmaker.

Oil the focus glass and use a magnifier.

All preliminaries being arranged, we proceed to

THE EXPOSURE OF THE PLATE,

Or taking the picture, which is thus effected:—

Place the cap on the lens, replace the focus glass by the dark slide containing the prepared plate, cover the top of the camera with the focussing cloth, and, with the hand under it, pull up the shutter; then, if you are taking a portrait, request the sitter to keep the eye upon a spot previously determined and the body perfectly steady, and uncover the lens for a space of time varying, according to the state of the light and the aperture employed, from one second to a minute or more. Nothing but experience and the result apparent on developing the plate will give the rule. Much depends upon the hour of the day and the season, and whether there is much light diffused from clouds or light coloured surrounding objects. Contrary to general expectation, the light is much stronger or quicker when there is an abundance of bright clouds than when the sky is unclouded; one great reason of which is, that it is more diffused and the shadows more illuminated, i.e., less

Precautions previous to, and during exposure.

Time the exposure for the shadows.

marked ; it is for these that our exposure must be timed: the parts in full light are seldom under-done. Again, the light from the blue sky is said to be "polarized;" hence, to have lost some of its photographic energy. Perhaps this may account for the dark shadows seen in most photographs of the East. Owing to the small amount of the actinic ray radiated by trees with leaves and all vegetation, a landscape, wherein much of these exists, demands a much longer exposure than one in which the principal features are architectural, or which consists simply of rocky scenery.

Vegetation demands long exposure.

Cæteris paribus, long focus lenses require longer exposure than short—near objects more than distant—and from reasons which will be very plain when we reflect for a moment :—of two lenses with equal aperture, that one in which the incident rays are the sooner brought to a focus, will necessarily be the quickest, because the whole bundle of rays is condensed upon a smaller surface, and *vice versa*. Again, the nearer an object is to the lens, the larger is it depicted upon the focus glass—hence the smaller is the actual number of rays which occupy a given space, and the consequent lengthening of the time ; thus an object the same distance in front of the lens as the focus glass is behind it, is copied of the natural size, and may be spread over the same actual space as would be occupied by a whole range of hills in the distance.

Distant objects less than nearer ones.

Having exposed the plate the desired length of time, replace the cap of the lens, close the shutter, and take the slide, covered with the focussing cloth, away to the dark room and proceed

TO DEVELOPE.

For "positives" we use one or other of the *iron solutions* described page 30.

Develope positives with iron.

Put the plate on the levelling stand and pour over it, from a clean measure, with *one sweep of the hand*, sufficient developer to cover it entirely; spilling a little over the edges is not important, provided that the solution be brought rapidly into contact with the whole surface of the plate. If the fluid be poured on all in one place, it will entirely denude that part of its silver and there will be no picture on it, hence the necessity of causing it to run all over in the manner above described. If poured on too slowly, it does not readily unite with the fluid on the plate, and a marbled appearance is the result, owing to the unequal action of the developer.

Importance of quick manipulation.

Within a few seconds after the developer has covered the plate, provided the exposure has been well-timed, those parts representing the *high lights* of the picture appear as well-defined light drab-coloured masses, and within a very short time *all the illuminated* portions become covered with a similar deposit. When this is the case, the action must be stopped by pouring on a large quantity of water. The result may be inspected by *diffused* light, and, if approved, the plate is to be fixed with cyanide, as will be presently described, and well washed subsequently.

Phenomena of development.

On inspecting the result, the picture being held over any black non-reflecting surface, it will appear with all the lighted portions represented by a deposit of metallic silver, which grows gradually thinner until it ceases

Appearance of the positive picture.

entirely in the darkest shades, and leaves them to be supplied by the black surface underneath.

On looking at the picture by transmitted light, the deposit appears so thin that in many places it barely intercepts the light at all—a very important distinction between it and the “negative” picture.

The terms *positive* and *negative* are entirely conventional on the part of photographers, and can scarcely be said at all to represent the ideas suggested on looking at either sort of picture; but as they are universally accepted, I do not think it necessary to adopt any other definition, although it is to be desired that some more definite term could be devised.

Definition of the
terms positive
and negative.

I will endeavour briefly to explain the meaning intended to be conveyed by the words. A “positive on glass” is a picture which, examined by transmitted light, has a very thin deposit of metallic silver extended over all parts except the very deepest shadows, and which in no part, except the highest lights, offers any material impediment to the transmission of even a feeble light. Backed up by a dark substance, and viewed by light reflected from its own surface, it should present a clean appearance, free from any mealy or powdery deposit in any part, and with an infinite gradation of the material, forming the image, on the lighted portion, and a *total absence* of it in the *densest shadows only*. The “negative” may sometimes present the latter appearance, but seldom does so; in fact, if it do, it very rarely proves a good one to print from. Its value can never be ascertained by this test; it can be properly appreciated only by being viewed held up between the eye and a source of light,

then it will be perceived that the deposit is of comparatively great thickness and density, the sky portion, if there be any, being almost absolutely impermeable to light, this opacity gradating uniformly away until it vanishes entirely, only in *absolute* shadow. Viewed by reflection, the whole surface is seen covered with a mealy deposit, which gives a more or less distinct idea of the subject represented, but which most frequently is a very confused one. The colour, moreover, is of a very decided yellow, in contradistinction to the positive, which is *evidently* of silver, more or less brilliant or specular.

THE NEGATIVE PICTURE

Is most generally developed with the pyrogallic acid mixture poured on in a similar manner to the iron solutions used for positives, but with more care, to avoid spilling any, as the silver solution retained by the plate is absolutely essential to the production of a perfect picture; and any lost cannot be entirely compensated for by some freshly poured on. These pictures develop much more slowly than the former; hence there is time to pour off the developer into the measure and pour it again on the plate, to insure equalization of admixture, and even to repeat this, if desirable; the highest lights are, of course, here also the first to appear, and they are followed by the lower, each in its special order, until the whole subject comes out in a precisely similar manner to the positive, which, in this state, it resembles so far that, if stopped at this stage, it might be used as one, though somewhat wanting in brilliancy. The development, however, must be continued much longer, and the liquid poured off occa-

Developer for negatives is pyrogallic acid.

Negatives develop more slowly than positives.

With which, in the first stage, they are identical.

sionally to view progress (by transmitted light), and this continued until the desired amount of density in the *lower* tones is obtained, when it is to be well washed and *fixed*.

On first pouring off the developer from a negative, there is a tendency to the production of straight brown stains, radiating from the edge which first becomes uncovered by the liquid, which, if the operation be done slowly, become permanent; they are avoided by not pouring off the developer too early, and by rapidity and dexterity of manipulation.

Iron developer
for negatives.

When the temperature is low, or the light feeble, it is sometimes desirable to employ the more energetic agent, iron, in the production of negatives; a modification of the process is then required. The collodion should contain a little bromide as well as iodide; one grain of bromide of cadmium, with one drop of tincture of iodine dissolved in one drachm of alcoholized æther may be added to each ounce of negative collodion. The iron developer to be used is that produced by formula No. 1, page 30; the picture is to be brought out until *all the details, though very thin and weak*, are apparent by transmitted light, when it must be well washed, and the due amount of *density* or *intensity* produced by redeveloping with the pyrogallie solution, with which 10 per cent. of a solution of nitrate of silver (30 grains to the ounce of water), not taken from the bath, has been mixed in a perfectly clean measure. Both these items are necessary, a *dirty* or *scratched* measure causing rapid decomposition of the fluids, and the bath solution precipitating immediately it is mixed with any of the developers, the result of which is that the picture is covered by a tumultuous precipitate of silver over every portion

Requires a special
collodion.

And that the
picture be re-
developed.

Necessity for
clean measures.

of its surface, and presents one phase of what is technically known as "fogging." In the foregoing description of the collodion process, I have supposed that the right exposure had been given, and that, consequently, the picture developed in a normal and proper manner; but I must now endeavour to explain the phenomena which present themselves when the exposure has been *insufficient* or too *protracted*. In the former case the high lights come out pretty rapidly, as usual, but are not followed in due time by the next lower; these appear but very slowly, and the lowest refuse entirely to appear, however long the development may be continued. An error in this direction is more grave than in the other, particularly in the case of negatives, as the higher tones being the only ones existing, take to themselves all the particles which should have gone to compose the whole picture, and hence become too dense, in fact, impenetrable to light; so that, in the subsequent printing, these remain perfect white patches on the paper, while the lower tones are equally black. The appearance presented is that known familiarly as "soot and whitewash." The same effect is produced by an acid bath.

Under exposed
pictures.

Simulated by
acid in the bath.

The over-exposed picture develops with great rapidity all over, half tones and high lights coming out all at the same time and with an almost equal degree of intensity, in fact, if much too long exposed, the highest lights become red and very translucent, and actually less dense than those many degrees lower. In this case nothing can be done but to prepare another plate. If but little over-exposed a very good result is often obtained by stopping the development with a stream of water as soon as possible,

Over-exposed
pictures.

and developing with a *fresh* quantity of liquid containing but a few drops of silver solution. An alkaline bath will produce the same effect as over exposure.

The tendency should be to slightly over-expose a negative, as this prevents the excessive *density* in the lights and *transparency* in the shades to which photographic pictures are too liable, and equally to under-expose the positive, in order to produce that brilliancy in white and black for which they are so valued.

Stains and
marblings.

In warm weather there is a great tendency to the production of stained and marbled pictures owing to the developer not flowing sufficiently rapidly over the plate ; sometimes this is occasioned by too much time having elapsed since its coming out of the bath, and will be remedied by re-dipping for an instant only. A bath highly charged, by long use with æther and alcohol, has a great tendency to produce longitudinal marks in the direction of the immersion of the plate, especially if the greasy appearance, evinced normally by every insufficiently excited plate, has not been got rid of before putting it into the slide ; the remedy for this is to boil a portion of the bath for a few minutes. Contact with the wood of the frames or cameras is a frequent source of stains radiating from the corners whereon only the plate rests ; this is obviated by wiping them out between each picture and putting on a little spirit varnish occasionally when they are put away. Opaque spots all over the negative, sometimes having tails more or less long, ("comets"), are produced by several causes—dust in the camera, which falls upon the prepared plate when the shutter is drawn up, floating particles in the bath,

Opaque spots.

also in the collodion. The remedies for all these are obvious : filtering in case of the bath—time for deposition on the part of the collodion. Small transparent spots are always produced by insufficient time being allowed for the collodion to settle before it is used after iodizing, using it from the same bottle in which it has been iodized, or disturbing some of the precipitated matter on pouring it out. Pieces of dry collodion falling on the plate produce *comets* of the first magnitude ; but, being apparent ere the plate is sensitized, if they would interfere with any of the details, of course such a plate need not be used.

Transparent
spots.

ON FOGGING.

Fogging is the great enemy of photographers, and he must be well skilled who shall define each cause thereof and provide against it. It is known by the plate developing all over the instant the solution is poured on, with or without any trace of the picture. Ammoniacal or sulphuretted vapours produce fogging of the worst description ; hence the tripoli mixture must not be used in the dark room, nor will a stable do well for the latter.

Fogging through
vapours.

Some collodions contain an alkali, or a basic iodide, which acts as such, and hence abstract the small quantity of acid from the bath. Occasional use of the litmus paper cannot fail to discover this and indicate the remedy.

Alkali-collodion.

White light coming through the yellow medium employed in illuminating the "Dark room" is detected by first ascertaining that the chemicals are all in good order, by sensitizing and endeavouring to develop a plate, using only a candle shaded by yellow paper as the source of light, then sensitizing one in the dark room, leaving it a

White light in
dark room.

minute on the level stand near the light, then pouring on the developer : if it take any effect within a minute, the light is in fault, and must be amended by extra thicknesses of the material which admits it. Yellow calico soon fades, but is readily dyed by immersion, first, in a weak solution of acetate of lead, then in one of chromate of potash.

By foggy atmosphere.

A foggy atmosphere will always produce a foggy landscape, and frequently a similar result in portraiture, due to the fact that the light is much weakened by its struggle through the yellow atmosphere, and acts but little on the prepared surface, the picture is, consequently, long in appearing, and the developer decomposes spontaneously, and stains the plate all over ; this is also frequently the case when the temperature is too low in the dark room.

By contamination of bath.

The *minutest* quantity of pyro', or the hyposulphite of soda, coming in contact with the silver bath, or the developer, will effectually spoil both, and require them to be discarded, the latter to be thrown away, and the former precipitated as chloride to save the silver.

Spontaneous decomposition in bath.

Pictures will sometimes fog, more or less energetically, owing to a peculiar and hitherto inexplicable decomposition which occurs spontaneously in the bath, and this more particularly in hot weather.

Cured by exposure to light.

Sometimes no remedy is to be found for it, but more frequently it will be found curable by the following means : Render the bath slightly alkaline by adding one drop or more of liquid of ammonia, and expose it to direct sunlight for an hour or more, then carefully neutralize the alkali by nitric acid, and filter through paper. This process of exposing the bath to sunlight is very calculated to frighten certain pseudo-chemists, who gravely assert that

nitrate of silver, as such, is decomposed by light. Such is not the case ; it is only affected when in contact with certain organic matters, and even then, in many instances, only very slowly ; the decomposition in the above instance goes only so far as to *burn off* the organic matter by the aid of the oxide of silver eliminated by the ammonia, and held in solution by the nitrate of silver, or the other nitrates existing with it.

A CHAPTER OF ACCIDENTS.

The causes of failure are so numerous, that I think it desirable to devote a short chapter to tabulating some of them in the order in which they are liable to occur. Most of them will be found mentioned in other parts of the work, but may fail, in their comparatively isolated condition, to make such an impression upon the would-be photographer as to be remembered by him at the critical moment :—

First, then : The light may obtain admission to the interior of the camera, between the two concentric tubes of which the mounting of the lens consists ; this depends on carelessness on the part of the maker, and he should be required to alter it ; it may be remedied temporarily by tying a piece of thick cloth around the inner tube, near to the back combination. To ascertain whether such is the case, leave the cap on the lens, take out the focus glass, and look into the camera from the back, the head being well covered with a dark cloth. The same means will enable us to detect light admitted through the joints of the camera, cracks, or minute holes. All these circumstances produce fogging of the highest intensity.

Failures from
the light finding
its way into the
camera.

Secondly: Direct light should never be allowed to fall upon the lens, particularly when it is worked with its full aperture. Theoretically, in fact, it should be protected from all light except that emanating from the object to be copied. Practically, this is impossible; but a sufficient approximation may be attained by the use of a suitable screen, or a hollow cone attached to the lens by its apex. Note, that these present a perfectly dead surface, or the remedy may be as bad as the disease. A reflection may take place from the interior of the double lens, when it is made, as some are very wrongly, without any central diaphragm. The single lens sometimes allows of such a reflexion, but it is easily cured by lining the interior with black cotton velvet. If the brass work project much beyond the posterior combination, reflection is almost sure to take place therefrom; the remedy is to get the superabundant metal turned off, if possible, or to cover it up with cotton velvet. Unless the interior of the camera be coated with a dead black composition, such as lamp-black and size, it allows of much reflection. Metal screws, nails, or hinges must be well coated with some similar composition. In large cameras it is advisable to place, midway between the lens and the picture, a rectangular diaphragm, with an aperture just large enough to allow of the passage of the cone of light.

From reflected
light.

Light penetrat-
ing the slide.

Unless the slide be protected by being covered with a cloth, the light frequently finds its way to the plate through the *slot* made for the shutter, and occasions partial or local fogging, like the other accidents in this category. During a very long exposure I have known the light to pass *through* the sensitive plate and cause a

fog on being reflected from the polished door of the slide. My method of always backing up the plate with red blotting-paper, effectually prevents this, *vide* page 39. The camera must be always carefully dusted out before an experiment is made with it, otherwise, particles are drawn in by the current occasioned by raising the shutter, fall on the plate and form nuclei for *comets*, and very often larger *stains*. Both the lens and the camera should be exposed *separately* for a short time to the sun, if he is shining and his rays are likely to fall on them when being used, otherwise, the moisture evaporated from the wood condenses on the glasses of the lens, and for some time quite obscures them. For the same reason the focussing glass, when taken from the camera, must not be laid on damp grass or earth. At page 8 I described an instrument for ascertaining whether the planes of the ground surface of focus glass and the sensitive surface of the prepared plate exactly coincided, showing the absolute necessity of such coincidence; and at page 2 I stated that our lenses must be achromatic. Sometimes, unfortunately, this is not the case, and the remedy I generally recommend, that of sending it back to the maker, may not be applicable.

Dust and moisture inside the camera.

Remedy for want of achromatism in lenses.

I will describe the method of ascertaining whether the foci are coincident, and of remedying the defect if they are not so:—Cut off 12 or 18 inches of the column of a newspaper, divide it into spaces of two inches broad, by ruling thick lines across it, and mark each division with a letter or number; paste this on to a board, and your focimeter is complete. To use it, place it at an angle of 45 degrees, and bring the camera so near to it that only one of the

Focimeter.

divisions is in focus, carefully test the focus glass and slide, then take a picture of the focimeter ; if any other number comes out sharper, replace the focus glass, and retract or project the lens until that originally focussed is reached, and you will thus obtain the correction necessary, when the object is at that particular distance ; when it is more distant, the correction will be less. One or two experiments will give the required correction for any determined distance of object. To facilitate the correction, a scale should be engraved on the lens-tube divided into sixteenths of an inch.

IN THE DARK ROOM

Ventilate the
dark room.

provision must be made for ventilation : as, if shut up too long, the emanations from the waste developing and fixing materials contaminate the atmosphere, and induce fogging. Pyrogallic acid should never be weighed in the dark room ; being so excessively light, the slightest current may bear it up into the air and deposit it in the silver bath, which it will entirely ruin. Hypo' must be rigidly banished from the same place. If it comes in contact with any of the cloths used for wiping the glass plates, it also may get into the bath, and prove equally ruinous.

Cover up the
bath.

Let the bath be well covered up while the room is being dusted, to avoid its being contaminated with floating particles which would settle on the film when immersed, and produce transparent or opaque spots on the picture, according to the nature of the material composing them. Particles of the collodion film must not be allowed to accumulate unduly in the bath ; it is not always necessary to resort to filtration to remove them ; emptying the liquid into the stock bottle, and decantation therefrom generally suffices.

It has been frequently asserted that by constant use a bath becomes super-saturated with iodide of silver : such cannot be the case, it is *saturated* when made and cannot possibly take up more. *Spotty* plates are said to be thus occasioned by the adherents of this theory. I am much more disposed to think this sort of accident is due to their putting acetic acid or an acetate into the bath, to compensate for a disinclination, their collodions have to produce the requisite density without the addition of some such contamination. Acetate of silver is somewhat soluble in the nitrate, especially when acidified and readily crystallizes on the plate on a reduction of temperature, or an alteration in the relative proportions of water and alcoholic æther.

Acetates in the bath.

Never add much *uniodized* silver solution to the bath ; it causes great want of sensitiveness in the next three or four plates immersed.

If a coated plate be *gradually* immersed in the bath, lines will be formed across it indicating each stoppage : similarly, if it be withdrawn soon after immersion, a marbled appearance will be produced, due to the repulsion existing between the æther of the film and the aqueous element ; the same markings will result if the liquids be not made to mix thoroughly before the plate is transferred to the slide. In hot weather, particularly, lines are apt to occur in the direction of immersion, by too great accumulation of alcohol and æther ; the remedy is to boil a portion as before directed.

Lines and marbling on the plate.

The solution accumulated at the lower edge of the plate, during the exposure, must not be allowed to run back over it during the developing ; it leaves a line of stronger development along the part reached by the wave. If a

plate becomes somewhat dry, and is not re-dipped in the bath before developing, the liquid does not flow freely over it, and a marbled plate is the result ; in hot weather, an addition of spirit of wine to the developer is often required to counteract a tendency in this direction, even when the plate has not been kept too long ; this is particularly the case with positives.

Opaque and transparent spots.

Opaque spots, with or without tails, are due either to particles of dry collodion from the lip of the bottle, or to suspended matter in the collodion or the bath ; these being visible contaminations can be easily avoided. Acetate of silver is not so and no one need run the risk of producing it.

Large transparent spots are occasioned by want of care in washing off the cyanide used for cleaning the plate. *Smaller ones* are due to fine particles in the collodion and are only to be avoided by giving the latter plenty of time to settle. A tendency to deposit them on the plate is partially obviated by pouring on plenty of collodion when the plate is being coated, and losing no time in pouring it back into the bottle. Most of the various phases of *fogging* are discussed in the preceding chapter.

Under exposed or "hard" pictures.

An absence of gradation in the picture is due either to insufficient exposure, too much free iodine in the collodion, or an excessive quantity of acid in the bath ; my readers will, I hope, avoid falling into the latter error, by careful use of their test paper and not giving ear to the recommendation of those who belong to that loose school of chemistry in which a "drop or two" of acetic acid, more or less, in the bath, is not considered objectionable. A low temperature in the bath and the developer will also produce a similar effect.

Excessive detail in both positive and negative, and want of density in the latter, may be produced either by over exposure, by want of a little color in the collodion, by the use of an alkaline collodion or bath, by the employment of *fused* nitrate of silver, or by the thousand and one causes of fogging, some of which are enumerated in the preceding chapter.

Over exposed monotonous pictures.

A too hasty immersion in the bath will often occasion the film to detach itself from the glass during the subsequent manipulations; the employment of a glutinous unsuitable collodion has also the same effect. Some are in the habit of developing in a shallow dish; this has a great tendency to induce *peeling*, as has also the use of hypo' for fixing. If any of the liquids employed, even distilled water, find their way between the film and the glass, the former will, in almost all cases, separate on drying.

Separation of the film from the glass.

Unless the fixing materials are well removed by copious washing, they crystallize on the picture being dried, and destroy its beauty.

Crystals in the film.

Previously to being varnished, a picture should be dried, otherwise it is very prone to crack: want of attention to this may have given rise to the report that amber varnished pictures crack—in my own experience I never knew them do so.

Cracks in the varnished plate

POSITIVES ON ENAMELLED CLOTH OR PATENT LEATHER.

A very ingenious method of transferring a positive from the glass to a less frail medium, in order to render it transmissable by post, &c., has been devised:

the operation is thus effected. The picture and material are both moistened with spirit, and pressed into close contact, care being taken to exclude all air bubbles; after being in contact some short time, it will be found that the film has separated from the glass and attached itself firmly to the enamelled surface: it should then be dried and varnished with colorless varnish.

ON WHITENING POSITIVES.

Alabastrine
positives.

Mr. Archer showed that a collodion picture, treated with a solution of bichloride of mercury, was first darkened by it and then slowly became a bluish white, evidently by the transference of half the chlorine from the mercury to the silver, to form chloride of silver, which remained in combination with the calomel, resulting from the other half of the chlorine still retained by the mercury. This process has been lately re-produced under the name of the "alabastrine," it offers certain facilities in coloring the pictures, and allows their being viewed non-inverted, that is, viewed from the back of the glass on which they are taken.

ON CONVERTING POSITIVES INTO NEGATIVES.

The same re-agent was employed by Mr. Archer to obtain a negative from a rather over-developed positive, and sometimes with tolerable success. It was first treated with a saturated solution of bichloride of mercury, until whitened, then washed and covered with a weak solution of ammonia or hypo': either renders it intensely black.

By bichloride
of mercury,
ammonia, etc.

Generally speaking, the negatives thus produced are very inferior, and never equal to those produced by the mode of re-development above described —Page 50.

Another mode which, in some hands, produces excellent results, is the following :—

Dissolve 10 grains of pure iodine and 20 grains of iodide of potassium in 1 oz. of water : treat the picture with this until it is all converted into iodide, then wash well and expose to the daylight for a few seconds ; take into the dark room and re-develop with pyrogallic acid and silver until the required density is obtained.

By iodine and
re-developing.

Both the positive and the negative require to be well washed ere we proceed to the next operation, viz.:

FIXING THE PICTURE

should be performed at a distance from the place or dish where the level stand used in developing is situate, as the fumes of the cyanide are injurious to the sensitive plate.

The proceeding is very simple, nothing more being necessary than to pour the liquid over the plate, and allow it to remain until all traces of the *yellow film* (iodide of silver) have disappeared ; when this takes place at the edges, it is certain that it is entirely removed from all the other parts. In negatives, it occasionally happens that, to the unpractised eye, it is only here visible. The plate is then washed with abundance of water, carefully poured on, so as not to break the film, which is now very tender, or insinuate itself between it and the glass, and may be immediately dried and varnished.

Care required
in washing.

VARNISHING,

If allowed to dry spontaneously, the film retains some traces of moisture which must be expelled by warming the plate, and then allowing it to cool before *varnishing*,

The picture must
be well dried.

the *positive* with (so called) *crystal* or *colorless* varnish, the *negative* with *amber* and *chloroform*.

Amber varnish
does not neces-
sarily crack.

Some time since considerable apprehension was excited by an announcement from one who was considered an authority, that all amber varnished pictures would crack and become lost. I can, from an experience of seven years, vouch, at least as far as that of my own manufacture is concerned, that I have never had an instance of a picture varnished with it cracking ; being in possession of negatives dating from that time, as are many of the first operators of the day.

A merely moist atmosphere does not affect them, nothing but actual wet allowed to remain long in contact will injure them.

Importance of
drying pictures
before varnishing

I happened to possess one which was in use during several years, and was frequently brought in contact for a moment with wet plates, without showing a symptom of cracking, although the film became mechanically scratched off in many places. It is important to attend to the above directions as to drying the pictures previous to varnishing, as otherwise, if there be any amount of moisture in the atmosphere, they will present a dull instead of a bright surface, altogether spoiling the positives and not affording the desired protection to negatives ; it is possible the want of this precaution might give the latter a tendency to crack.

MOUNTING OF POSITIVES.

Positives require something black behind them on being mounted ; for this purpose nothing is better than a piece of dead-black paper or velvet ; these should be applied to the side on which the picture is taken, and the image viewed *through* the glass, by which means it becomes non-inverted ; which is not the case when black varnish is used, as this

must be put on the glass side, its tendency to penetrate the film and to crack rendering it inapplicable on the picture surface. Positives are sometimes taken on dark blue glass and look very well, but they have the above inconvenience of presenting the right for the left.

In the foregoing pages I have endeavoured to give as lucid an explanation of the wet collodion process as I consider possible ; but I am far from flattering myself that my teaching will enable the tyro to become a skilled photographer, even though he expend much time and exercise laudable patience. Wherever the opportunity presents itself, I should advise him to avail himself of the assistance of an expert.

I shall feel myself sufficiently rewarded if I have helped, in some measure, to smooth away a few difficulties, and render explicable certain phenomena which might otherwise have proved insurmountable obstacles.

I now beg to direct my reader's attention to certain modifications of the process, which have already produced very admirable results, and appear still full of promise.

ON DRY COLLODION PROCESSES.

WHERE the necessary conveniences are procurable, the wet collodion process is certainly the best in all respects ; but want of means of transport, scarcity of water, and many other circumstances, may combine to render a substitute desirable; such may be found in the modifications of it, which it will be my province next to describe. Their name is Legion; but I shall restrain myself to three only, as these, in my judgment, are the best yet propounded; and they have the further advantage of serving as types for all the rest. We have not yet arrived at making any equal the wet in point of sensitiveness, but with respect to their results, they leave nothing to be desired: in fact, under certain circumstances, where deficiency of light, as in *interiors*, or extreme contrasts of light and deep shadow, demand a long exposure, one of them (Fothergill's) offers decided advantages over the wet plate, as the high lights exhibit very little tendency to "solarize," that is, to become red and translucent, a phenomenon so common in the ordinary process.

MR. MAXWELL LYTE'S PROCESS.

Nitrate of silver	.	.	.	.	.	100 grains.
Iodide of potassium	.	.	.	.	.	2 "
Distilled glycerine	.	.	.	.	.	4 fluid ounces.
Good honey	.	.	.	.	.	2 ounces weight.
Distilled water	.	.	.	.	.	4 ounces.

Dissolve the nitrate of silver in an ounce of the water, and add to it the iodide, previously dissolved. Mix the honey and the glycerine with the remainder of the water, then add the silver solution, and expose to good diffused light for some hours; the result of this will be the blackening of the liquid, owing to the reduction of a small portion of the silver by means of certain organic matters which (this very fact indicates it) want removing; now add to the mixture one drachm of purified kaölin, (china clay); let it settle twelve hours in the dark, and it may be poured off clear, or filtered off for use, provided it presents the very slightly acid reaction required in the case of the bath. The mode of applying it is the following: coat a plate with negative collodion colored (if necessary with tincture of iodine) a very pale orange, excite in the usual manner, and, holding it by one corner in a slanting direction, pour along one edge sufficient of the above syrup to displace the fluid from its whole surface; allow it to drain for a quarter of a minute, then cover with some more syrup, and let it rest on the level-stand for a minute or more; finally drain the plate well, resting one corner on two or three thicknesses of clean blotting paper supported on glass, and the other against a piece of ground glass attached to the wall. Care must be taken to turn the sensitive surface towards the wall while it is drying, to avoid its fixing the dust, which is always present to some extent, floating about in the air of the dark room, notwithstanding every care may have been taken to clean the latter well out, and allow the dust to settle before the operation is begun. These plates are very sensitive; perhaps they will require only twice or three times as long an exposure as a wet collodion. Mr. Lyte at first believed that they were actually more

Lyte's process
modified.

Method of coating
the plates.

Of drying them.

sensitive than the wet plates, having taken several large sea views quite instantaneously; but longer experience has not confirmed this idea.

They retain their sensitiveness for many hours in tolerably cool weather, but are not to be depended on, if kept more than six, if it be very warm.

To be kept in tin
boxes

They should be preserved in tin boxes made very airtight, and lined at the top and bottom with blotting paper, hot-pressed, in order to prevent particles from detaching themselves and adhering to the somewhat "tacky" surface.

Developing dish.

They are developed with pyrogallie acid solution, in a glass dish made for the purpose, just sufficiently wide to contain one picture and a little longer, and so constructed that it is deeper at one end than at the other.

Mode of de-
veloping.

The method of developing is as follows: the plate being slightly moistened at the back, is placed in the plate-glass dish, at the shallowest end, where it adheres; the dish is then tilted, and into the well formed by the deeper end is poured sufficient pyro' solution to cover the plate, which it is made to do by depressing the shallow end; the liquid is made to flow to and fro several times to insure perfect permeation of the film, and then allowed to rest level until all the details are apparent; if sufficient density is not produced ere the developer becomes cloudy, the latter is thrown away, the plate washed and then intensified with fresh pyro' and silver, as directed for negatives, page 50.

MR. SHADBOLT'S PROCESS

was published almost simultaneously with Mr. Lyte's; but has been shown to be quite original as far as Mr. S. was concerned. It consists of covering a sensitive plate in

a manner precisely similar to that prescribed above, with a syrup, the formula for which is given below. The same precautions as to draining and drying are to be observed as in Lyte's process. The plates are less sensitive, (requiring four to five times as long as the wet), but they will keep much longer, 24 hours or even two or three days under favorable circumstances : they are developed by being first Developing. immersed in distilled water to get rid of the sugar ; then placed level and covered with solution of pyro' mixed with one-twentieth its bulk of 30 grain solution of nitrate of silver ; more of the latter may be added if sufficient density be not produced by the first dose.

Shadbolt's Syrup.	{	Good honey	6 ounces
		Distilled water	4 „
		Spirit of wine	1 „

Mix well and filter through paper.

The syrup used in Lyte's process may be returned to the bottle after being used, exposed to diffused light, decolorized by kaölin, and used again and again until expended. The first dose in Shadbolt's must not be used a second time, but the last may be used for clearing the nitrate off the next plate.

Innumerable modifications of these processes have been published, many of them remarkable only for their extreme absurdity ; but there is only one which calls for any remark, and that is the oxymel process. This, in the Oxymel process. hands of its author, Mr. Llewelyn, has produced some very excellent results, and consequently met with much approval ; but I consider it a step quite in the wrong direction. Oxymel is composed of honey and *much* acetic acid. The superiority of the collodion over all other

processes consisting in working with materials almost absolutely free from acid, hence its superior sensitiveness, it is evidently departing from it and going back again towards the days of waxed paper, when we combine it with such a compound as oxymel, which, besides, presents no superiority over plain honey syrup.

THE ALBUMEN PROCESS.

Iodized Albumen.	{	White of egg . . .	1 ounce.
		Distilled water. . .	1 drachm
		Iodide potassium . . .	6 grains
		Pure grape sugar . . .	10 „

Mix the above materials in the order indicated, beat them into a froth, and throw this into a funnel over which a piece of fine cambric has been spread, cover from dust, and place in a warm situation until it has become perfectly liquid and strained through into a bottle placed beneath : allow the resulting material to subside for twelve hours, then pour off the clear portion for use.

Having carefully cleaned a glass plate, as for the collodion, pour on the iodized albumen, and return the excess into the bottle in precisely the same manner ; the lower edge of the plate will be seen not to part readily with the remaining albumen. To effect this, you must breathe upon that portion for a minute or more, and finish the draining by allowing this part of the plate to rest on a pad of blotting paper, placing it at an angle against a support, so that the coated surface may be protected from dust while drying. As many plates as may be desired can be thus prepared while the albumen remains fresh ; this stage of the operation is completed by drying each in its turn over a spirit lamp or wire gauze gas burner, taking care to apply the heat

cautiously at first round the edges, and gradually to diminish the circle until the centre is dry.

The plates are excited by cautiously applying the iodized surface to that of a solution thus made :

Aceto-Nitrate of Silver.	{	Nitrate of silver	150 grains
		Distilled water	3 ounces
		Pure glacial acetic acid . .	2 drachms
		Iodide of potassium	2 grains
Mix and filter.			

and allowing it to remain in contact one minute ; they are then washed by pouring a gentle stream of distilled water over them ; and, after being allowed to dry spontaneously, may be put into a tin-plate box and preserved for use precisely as if they were sensitive waxed paper. The time of exposure in the camera is about the same as for the latter, and the development is conducted in the following manner : The plate is immersed in a glass vessel containing a saturated solution of gallic acid, mixed with only two or three drops of aceto-nitrate mixed for the purpose, and free from any contamination with iodide. Several plates may be developed in the same bath, provided means be taken for keeping them from contact one with another. They come out very slowly, requiring several hours, but require watching from time to time, lest the solution should become dirty ; if it do so it must be thrown away, the bath thoroughly cleansed and a fresh quantity mixed. This is a process which has found very few votaries in this country, and fewer successful ones.

I do not give the formula on my own authority, it was given to me by a gentleman who has had much experience with it and very uniform success in climates where the heat was intense and circumstances very unfavourable

to photographic experiments. Our neighbours across the channel produce very brilliant results from the albumenized plates, *vide* the stereoscopic transparencies of Ferrier, &c., &c.

FOTHERGILL'S DRY PROCESS

appears to me to be the best of all yet published, and the most full of promise for the future ; combining, as it does, a very great amount of sensitiveness and almost unlimited keeping qualities, with great facility for manipulation and easy development ; and the following modification of it I have found to possess the greatest possible amount of these desirable properties :—

Ammoniacal	{	White of a fresh egg -	-	-	1 oz.
		Distilled water -	-	-	3 "
Albumen.	{	Liquid ammonia	-	-	5 minims

Shake well together for some minutes in a bottle two-thirds full, let it rest twelve hours, then filter through paper and allow it to settle another twelve hours, and filter again. After this it will keep bright for a very long period ; if not refiltered, a scum rises to the surface and produces innumerable black spots in the plates coated with it. Much has been said, and perhaps more written, upon the preparation of a collodion suited to this and other similar dry processes, the general tendency being to place confidence in one which leaves a somewhat powdery film ; this I think is an error, it should be of a loose spongy character, slightly less tenacious than that which experience has shown to be the best adapted for negatives ; in fact, it can be prepared from the same collodion somewhat diluted and modified as in the following formula :—

On the proper
kind of collodion.

Collodion for Fothergill's process.	{	Iodized collodion, prepared		
		as at page 21	- -	3½ oz.
		Alcoholic æther	- -	6 drachms
		Bromide cadmium	- -	2 grains
		Tincture of iodine	- -	4 drops
		Iodoform	- -	1 grain

Have ready three similar sized baths; one containing the ordinary nitrate solution, 30 grains to the ounce, and exhibiting the usual very slightly acid reaction; another containing a solution of lump sugar, 1 oz. to the pint, and a third a solution of nitrate of silver, $1\frac{1}{2}$ grain to the ounce. Coat a plate with the above collodion and excite it as usual, then immerse in the sugared water for a minute, and afterwards rinse it well by a stream of water; then dip it in the weak silver bath and leave there while another plate is being coated, &c.; then remove to the level stand, and cover at once and without hesitation with the alkaline albumen, half-ounce for each thirty square inches of surface; let it rest a minute, and finish by washing off with an abundance of ordinary water.

Coating and
exciting.

First washing

Re-exciting.

Final washing.

The drying is to be allowed to proceed spontaneously until the film no longer appears moist to the eye, and then perfected by the plate being supported by some bad conductor over a close vessel in which water is kept at about 212 degrees, or it may be dried on a brick heated to about this temperature enveloped in blotting paper.

Drying

The plates must be stored in tin boxes quite air-tight, as the emanations from wood would spoil them sooner or later.

Plates must be
kept in tin.

The exposure is about five times as long as wet collodion. I have taken very perfect pictures, including architecture and vegetation, with a quarter plate combination lens, $\frac{1}{2}$ stop between the lenses, in half a minute in summer

light. To develop, first immerse for two minutes in distilled water, then place level and cover with the following :—

Developing
solution.

Usual pyrogallic solution	6 parts
Saturated solution of gallic acid	1 „
Nitrate silver solution (10 grs. to 1 oz.)	3 per cent.

Intensifying.

If the exposure has been properly timed, the picture will appear within five minutes, and then steadily progress for ten minutes or a quarter of an hour, during which time it must be carefully watched, and if the developer show any tendency to become dirty or cloudy, it must be thrown away, the plate washed, and covered with some fresh. When all the details have appeared, the requisite intensity may be produced by adding an extra dose of silver.

To be fixed by
Cyanide

Precautions
against blisters

It is fixed in the ordinary manner with cyanide, taking more than ordinary precaution to extract all the iodide from the edges where the film is thickest, otherwise the film is very liable to rise in blisters at these parts and peel off in drying. Care also is necessary to prevent the cyanide or water from getting under the film, which frequently happens in places which may have become scratched or denuded. Covering the plate entirely with collodion and using plates with ground edges very effectually prevent this, which, if it occurs, generally causes peeling off of the film while drying.

And peeling.

The above description may appear long and intricate, and the manipulation tedious ; but, in reality, it is not so. A number of plates are generally prepared together, hence the several portions of the process may be going on with different plates at the same time, and a dozen easily prepared and dried in an hour and a half. Again in

developing, it is easy to procure a level stand, which will hold six plates, and all these may be attended to at once, without in any way interfering one with the other.

The difficulties peculiar to this process are the dark spots above described, and a tendency of the film to rise in blisters ; the first is avoided by employing liquids entirely free from any floating particles, and the latter by destroying the tenacity of the film with iodoform—a property I have long known that substance to possess, and which, I believe, I am the first to apply to photography.

Action of
iodoform.

I discovered it in 1852 while experimenting on organic compounds of iodine as iodizers for collodion. It is not advisable to mix much of the above collodion, as it very soon decomposes. Other difficulties which at first appeared insuperable were *marblings* all over the plate; they were occasioned by attempts to wash the plate by mere affusion with a small quantity of water ; they are entirely avoided by the plan of the three baths I recommend.

The theory of the process, at first sight, does not appear to be very plain ; but, I think, the following, if not absolutely the true one, will be found to approximate very closely to it. The plate being washed thoroughly, can retain no nitrate of silver ; yet there is some compound of silver besides the iodide, that alone being insensible to light. From certain experiments I have made, I am inclined to think that the sensitive material is composed of chloride of silver in intimate combination with organic matter, that the latter exists there cannot be a doubt ; of the presence of the former I was at first doubtful, thinking that the ammonia in the albumen would prevent the precipitation of any chloride ; but further experiments

Theory of the
process.

confirmed the matter. Chlorides precipitate ammoniacal nitrate of silver when there is no great excess of the alkali : the chlorine is of course derived from the albumen.

Modification.

Acting on these ideas, I find that almost any organic substance, which is not directly a reducing agent, dissolved and mixed with one half per cent. (.005) of chloride of sodium will answer the same purpose; but in none do I find any advantage over the albumen.

STEREOSCOPIC PICTURES

are now too well known to require a description at my hands ; their effect, as viewed in the instrument, is to reproduce perfectly (when the angle is not exaggerated) the object as it appears before our eyes in nature. As to the relative angle at which the two pictures should be taken, authorities differ widely ; some contend, and with great justice, that the distances between the lens which takes one picture, and that copying the other, should be invariably $2\frac{1}{2}$ inches, or the average distance between the pupils of the eyes ; while others would have the angle included between lines joining the object, and each lens maintained invariable.

The former would wish every object in nature represented as *they see it*. The latter as it would appear were it represented by a small model, placed at a distance of a few feet. I certainly am more inclined to the latter view of the case, as distant objects *in nature do not stand out* with great relief ; but if we obtain two pictures of them at the same angular distance, as would be the case if we had a perfect model five feet from our eyes, I cannot but think a much more pleasing effect is produced.

TAUPENOT'S PROCESS

preceded Fothergill's, and has attracted much attention. It consists in coating a collodion film, containing pure iodide of silver, with albumen, which has been in contact with fermenting sugar, drying and sensitizing in aceto-nitrate, &c., The manipulation is very tedious and uncertain, and needs no further description at my hands, as I consider its every step a mistake. Weak points of

Various gelatine processes have been published, but in none have I found any advantage. Dr. Hill Norris claims to have discovered a valuable modification of it, but his published formula does not appear to bear this out. I am not aware that his mode of preparing the "patent dry plates" has been made public. Gelatine process.

STEREOSCOPIC TRANSPARENCIES.

These very beautiful pictures may be readily produced by Fothergill's process, provided negatives of the right description be made on purpose; these should be very slightly over-exposed and developed with iron, according to the method described, page 50; and very little, if at all, intensified.

The development should be conducted slowly: a very minute quantity of silver being employed, and no intensifying being resorted to, and the printing pushed rather far so as to avoid those snow effects which are so common in all kinds of photographs, particularly those which are stereoscopic. The glass used should be the fine ground patent plate coated on the smooth side.

ON THE PRODUCTION OF
ENGRAVED PLATES
BY THE
AID OF PHOTOGRAPHY.

VARIOUS methods of effecting this desirable result have been devised and proved more or less successful, and some few patented. The most successful, as it appears to me, are those based upon the susceptibility to the action of light of a stratum of gelatine, impregnated with the bichromate of potash. Experiments upon a very extensive scale were carried out in this direction by a company formed for the purpose, working under a patent granted to Mr. Paul Pretsch ; but, although full of promise, they appeared to fail from the plates requiring much "retouching" by the engraver before they were fit for being printed by the ordinary copperplate process. I possess, however, a plate produced by the above process, considerably modified, which exhibits not the slightest trace of "touching," and in which the existent defects are all due to the negative employed, that being one eminently calculated for our present mode of printing ; but, for reasons I have before stated, not the best adapted for printing by development. The proofs from it are very beautiful, but could not compete in cheapness of production with the ordinary silver print,

from the great care and skill required from the printer, and the extreme delicacy of the copperplate itself.

I will briefly describe the steps of the process, as far as they have been made public. A certain portion, viz.: the mode of producing what is technically known as the "grain" in copperplate printing, still remains the secret of the producer of the above plate, which represents a copy of an ivory carving by Albert Durer. Take one part of a saturated aqueous solution of bichromate of potash, and three parts of gelatine which has been soaked for two hours in cold water, melt these together in a water bath, then paint this thickly over a glass plate, previously rubbed over with purified ox-gall; dry it as quickly as possible in a warm situation, then press a piece of Towgood's paper, previously moistened, into intimate contact with the gelatine, and the latter will adhere to it and may be easily lifted off the glass plate. Now procure a negative collodion picture, non-inverted, by using the "parallel mirror" attached to the lens in the manner employed by the old daguerreotypists, and develope with iron, so as not to get too great contrasts. Superpose this on a dry collodion plate, which expose and develope in its turn not too strongly. This must be used to print upon the gelatine by exposure in an ordinary pressure frame, in a strong light for ten or fifteen minutes. On immersing the sheet of gelatine subsequently in water those parts acted on by the light will be found almost indifferent to water, while the protected portions will swell up like ordinary gelatine, and project above the insulated portions which represent the lights of the picture.

It is here that the process of graining is effected, during the metallization of the gelatine, which is necessary to

adapt it for receiving the coating of copper by electro deposition, which constitutes the last stage of the process.

The resulting copperplate presents the usual well-known appearance of one produced by the artist, having its printing surfaces depressed, and possessing more or less "grain" according to the required density of the shadows.

I should mention, that before being subjected to the action of the battery, the back of the gelatine plate must be attached by any suitable resinous cement to a glass plate, as otherwise it would float in the copper solution.

PAPER PROCESSES.

THE POSITIVE, OR PRINTING PROCESS.

For the prosecution of this most important and final step, towards which all our previous exertions have tended, Apparatus. we require but a small increase in our apparatus, viz. : three glass or porcelain dishes and

THE PRESSURE FRAME ;

a rectangular frame of wood, with a rebate serving as a support to a thick glass plate, backed by the pressure board, lined with some soft material, and consisting of three pieces hinged together in such a manner that the outside thirds may be individually lifted, for inspecting progress, without disturbing the remainder. The pressure is obtained by means of four screws working through cross pieces hinged to the frame, or sliding in grooves made for the purpose : or by means of springs.

For printing stereoscopic pictures, or those not exceeding six by five, a more simple form may be employed, but need not here be particularized. Beside these, a few pins bent like **S** or "American clips," and a portfolio, are all the necessary apparatus. Stereo' pressure frame.

THE PAPER.

It is essential that certain properties be found to reside in this, viz. : that it be fine and close grained, with a very smooth surface, and sufficiently permeable to the liquids

Essential
properties.

English paper
for salting.

A starch sized for
albumenizing.

employed, without being rendered by them prone to be readily torn during the long series of washings and manipulations to which it is to be subjected. It should also be without any "water-mark," and most especially free from metallic or other particles which induce ineradicable defects in the pictures. Opposite qualities are demanded according to whether the paper is to be used without any further preparation than mere "salting," or is to be "albumenized and salted." For the former purpose, English paper is decidedly the best. I have for many years recommended and sold a certain quality of Towgood's, and still find it the best in the market. It is used for "plain paper" pictures, and for such as are to be "touched" or painted in water colours. At present, the only qualities fit for albumenizing are of foreign make, their being sized (at least in part) with starch confers upon them a certain permeability by the very glutinous liquid, without detracting much from their strength or rendering them bibulous; but I have every hope that in the course of a very short period, we shall procure home-made papers possessing all these desirable properties, together with others which have been hitherto unattainable in the foreign.

Salting solution for paper.	}	Chloride of ammonium.	100 grains.
		Distilled water . . .	10 fluid ozs.

Immerse Towgood's paper in this fluid, a sheet at a time, carefully avoiding carrying down any air bubbles, and cause the liquid to flow freely over the top surface of one before the next sheet is put in, until about a dozen are in the dish, then turn over the mass, pick out the bottom sheet (now uppermost) and attach it by means of a bent pin, by one corner, or by two if the sheet be large, to a line to dry.

Any number of sheets may be prepared in the same bath ; but it must not be stored away for future use.

Will serve for any number of sheets, but must not be kept after using.

ALBUMENIZED PAPER.

Replace either one-half or almost all the water, in the preceding formula, with the white of fresh eggs ; add to each pint ten drops of glacial acetic acid, and shake the mixture well up for a quarter of an hour in a bottle only two-thirds full ; let it repose twelve to twenty-four hours, then strain through fine muslin, and you will have the albumenizing solution.

Liquid for albumenizing.

On this the paper must be floated ; it must not be immersed as in the operation for salting. Having ascertained which is the "right" side of the paper, take a sheet by the opposite corners, allow it to bend in the middle, and place the convex portion on the surface of the liquid, previously carefully freed from bubbles or floating particles ; then lower the ends gradually, in such a manner as to avoid including any air, or allowing the albumen to intrude over the edges. After remaining from three to five minutes, according to the dilution of the albumen or the contrary, and the permeability of the paper, it is to be lifted up by both corners of one end, allowed to drain a minute, then suspended to dry by two wooden clips securely nailed at the required distance apart on a lath fixed in a horizontal direction, in a room kept at a temperature of 70 degrees Fahrenheit, and very free from dust. Before being stored away, each sheet should be finished by drying before a fire or by means of a hot iron. The above process is a difficult and tedious one, and need never be resorted to by the amateur in this country. Albumenized paper has become an important article of commerce, it is produced at a very moderate

Modus operandi

Drying.

price, and is much more perfect as to its surface, &c., than it is when manufactured only in small quantities at a time.

It is used for almost all pure or untouched photographs, and appears to answer perfectly for those intended for being painted in oil colours. Pictures for the stereoscope would have lost half their charm, had not this mode of preparation been discovered. I may perhaps here be allowed to mention incidentally, that the latter pictures may be still further improved in beauty by being French polished with colorless polish after being mounted; the process, however, is not very easy to be explained in words, although simple enough after being once seen.

TO EXCITE THE PAPER,

take it into a dark room and *float* in the manner above described on the surface of

The silver solution.	Nitrate of silver, crystallized	4 drachms.
	Distilled water	4 ounces.

carefully abstaining from wetting the back; when the paper loses its rigidity (usually in about three or four minutes) take it out, pass a pin through one corner, and hang it to dry on a line, attaching a piece of blotting paper to the inferior angle. Few sheets must be prepared at once, as they will not keep many days, even though preserved in a close dark portfolio. If kept in a close box containing chloride of calcium, it will keep much longer. This constitutes the nitrated or positive paper.

The albumenized paper is excited in a similar manner. The nitrate of silver solution used in this process should be excluded from white light, and only made in small quantities; it speedily becomes brown from use, and tinges

the whites of the proofs yellow, but this color may be got rid of by keeping a small quantity of kaölin (china clay) in the bottle used for containing it, and filtering off for use.

How to purify.

It is found that the strength of this solution diminishes very rapidly by use, so much so, that several sheets of albumenized paper, floated consecutively upon a small quantity of liquid, deprive it of silver to such an extent, that the albumen no longer coagulates on coming in contact with the surface liquid, but actually dissolves in it, and is precipitated on reaching the richer strata of liquid below. I therefore recommend, that after floating four papers, a portion of silver solution, containing 80 grains to the ounce, should be added to the bath, to compensate for the silver, of which the paper has deprived the remaining liquid, and that the bath be well stirred after each addition before another paper is excited.

Strength is rapidly reduced by use.

Must be strengthened by an 80-grain solution.

The paper thus prepared, is impregnated with chloride and nitrate of silver in combination with the organic matter of the albumen, and hence is a very delicate material ; it must, as before remarked, be kept from contact with light and chemicals of all sorts, particularly with the developers, cyanide, and especially hypo'; the minutest trace of either, brought into contact with it, either before or after excitation, leaving large brown or black stains ; hence the fingers must be kept free from meddling with other photographic processes while paper is being sensitized.

Constitution of sensitive paper.

Causes of stains

It is absolutely impossible to procure a paper entirely free from particles of iron or copper, contracted from the rags of which it is manufactured, or from the machinery used to tear them to a pulp, therefore we must put up with the spots produced by these foreign particles, and take care

And spots.

that they do not interfere with the more vital portions of the picture, by placing them judiciously under the negative in printing.

ON PRINTING.

This most important operation, the ultimate aim of all our previous operations in the production of negatives, requires more care, painstaking, and practice than all the others, combined with no small amount of artistic knowledge.

The negative, it will be remembered, is a picture in which the portions which are perfectly white in nature, are represented by an opaque deposit of silver, which becomes more and more translucent, until it ceases altogether in those parts where absolutely no light struck the plate, and here the glass retains its original transparency. Now, the sensitive paper, which is perfectly white, being put under the negative, and duly pressed into contact with its film surface in the pressure frame, and exposed to strong light, becomes colored by its influence exactly in proportion to the transparency of the negative, or protected by the want thereof. It therefore terminates in representing the original object with all its subtle gradations of light and shade; but if, when this point is exactly reached, it were exposed to the after processes, it would lose some little, we must therefore over print somewhat to compensate for this. It is a very general plan to print by direct exposure to the sun, and when we have a perfect negative, this no doubt is the best plan; but if the negative is weak, it is better to avoid his direct rays.

A very general defect in negatives is a weakness or transparency of the sky in landscapes, and the same or

Rationale.

Pictures require
over-printing.
Exposure to the
light.

similar defects or holes in the back ground of a portrait; these may be remedied in two ways, either by "painting out" the offending portions with a mixture of black varnish, painters' dryers, and lamp black, thinned down with turpentine (this plan pre-supposes an acquaintance with the use of drawing implements), or by cutting out a "mask" of those portions and pasting this on to the glass side of the negative. It is thus effected: a sensitive paper is placed under the negative and exposed until lightly printed, the sky or back-ground is then carefully dissected away from the other portion of the picture, with a pair of scissors, and each part afterwards exposed to the light until "bronzed," then fixed in hypo', well washed, and the sky or back-ground attached to the negative as above described; placing it on the opposite side of the glass to that on which the picture is, prevents the hard appearance which would result if it were applied upon the film side. The other "mask" is reserved in order to be employed as a cover to protect the corresponding portion of the positive proof, should it be deemed advisable to produce a tint upon the sky or back-ground after the other portion has been printed, this is effected by simply covering over the figure or landscape with its appropriate mask, and leaving the remainder exposed to light for the requisite time. Having therefore somewhat over printed your proof, take it from the pressure frame, and as soon as is convenient, immerse it in the

Remedying a defective sky or background in a negative.

Fixing Bath.	{	Hypo-sulphite of soda	2 ounces.
		Water	6 "

taking care to cover it very quickly with the liquid on both sides, and to avoid any air bubbles, as these if allowed to remain attached only a few seconds, would leave dirty

Mode of im-
mersing the
"proofs."

marks on the parts where they rested ; the best method of avoiding these is to float the proof carefully, so as not to include any bubbles, upon the unprepared side, then to sink it by brushing the liquid over the other with a brush, continuing this on each side alternately, until the paper no longer floats. The pictures should finally all rest with the albumen surface downwards, as this continues for a long time to exhibit a repellent action on the bath, and if not covered by it, stains are the result.

Weak daylight
not injurious.

This and the following operations may be performed by diffused light, if not too strong : therefore need not be done in the dark room, whence I recommend hypo' to be strictly banished.

After remaining in this bath three or four minutes, each picture is to be removed singly, and well streamed under a tap, so as to deprive it of all the silver salts, and then immersed in the

Toning Bath.	{ Hypo'	2 ounces.
	{ Water	6 "
	{ Chloride of gold	4 grains.

Order of mixing.

The hypo' must be first dissolved, then the gold, previously mixed with $\frac{1}{2}$ oz. of the water, added a little at a time, the liquid being kept constantly stirred. It must then be allowed to settle twelve hours, and the deposit of sulphur, which always occurs, separated by decantation or by the filter. On first coming from the press, the proof is of a beautiful maroon colour, (any portions which have overlapped the negative, and consequently been unprotected are bronzed), the effect of immersion in the fixing bath, is to change this into a disagreeable reddish brown, hence the necessity for the toning process. According to the

Phenomena of
toning.

time the picture remains in the last bath, is the depth of colour reached, passing from a sepia through all shades of maroon or plum colour, until it finally becomes intensely purple black ; the operation may be stopped at any period when the tone reached seems most suited to the object represented. The proof must be then well rinsed under a tap, plunged into a large quantity of water and allowed to soak for half an hour ; if a current of water be kept running through the vessel all the time, it will be all the better ; at the expiration of this time, each proof should be taken separately from the vessel, rinsed under the tap and plunged into another vessel of water ; a repetition of this three or four times is sufficient effectually to deprive them of all soluble chemicals remaining in their tissue, and protect them as far as these are concerned. It is infinitely preferable to any self-acting apparatus for changing the water : one very ingenious washing apparatus I will however describe, as it may prove serviceable to those whose avocations do not permit them to watch a process during so long a period : procure a common brown-ware baking dish, drill a hole large enough to admit a wine cork through the most depressed portion of the bottom, if there be any such, and through the cork pass a syphon of large bore, whose shorter limb terminates inside and flush with the bottom of the pan, and whose bend rises not quite as high as its rim, and the apparatus is complete. To set it in action, half fill the dish with water, put in the proofs one by one, and let a small stream of water run into it ; as soon as the level reaches its bend the syphon will come into action and speedily empty the dish, and repeat this as often as the vessel becomes full.

Washing.

Self-acting washing apparatus.

Fixing bath soon
spoils.

Toning not to be
kept too long.

On fading.

Sulphur-toned
prints must fade.

The above fixing bath must not be used during more than half a day. The toning, having had fresh gold added to it each time it is put away, must be discarded as soon as it deposits a brown crust on the sides of the bottle in which it is kept, or whenever it shows the least tendency to produce a yellow tint in the whites of the proofs. The latter is due to a decomposition of the hyposulphite of silver, the exact nature of which is not known, but whose results are that photographs have obtained a very bad name as being very generally prone to fade, in fact some have gone so far as to say that all will fade; I cannot agree with this, believing as I do that when produced by the above formula, or by that to be presently described, they consist principally of metallic gold and in less degree of silver. I cannot deny that most yet produced will very likely fade, and from the very reason that the precautions above described are not followed by one photographer in twenty, although they know the penalty; "it is so much easier to get good colors when the fixing and toning baths are in one:" they do wilfully what they know to be wrong, and then hope that abundant washing will fix the prints which they have wantonly contaminated with a decomposable sulphur compound. It will do no such thing.

Alkaline gold bath.	{ Chloride of gold	2 grains.
	{ Carbonate of soda	10 "
	{ Distilled water	4 ounces.

To be fresh mixed

How to replenish
it.

This is a very valuable solution for toning, but must be newly mixed when used, as it will not act well if kept a few hours; but it may be made to act well several different times by adding occasionally more gold, and its equivalent of carbonate (not bi-carbonate) of soda.

The proof to be treated with this bath must be first soaked in water, to wash out (and consequently save) the free nitrate of silver, then rinsed under the tap and immersed two minutes in a bath containing water one pint, common salt, one ounce : this is for the purpose of converting all the silver into chloride, the nitrate decomposing all solutions of gold.

Manipulation
therewith.

The toning is to be effected in very obscure light, and is quickly done, not occupying more than five to ten minutes. The proof must be then fixed in clean hypo' and carefully washed, as in the other instance. Various modifications of this have been propounded, but they appear to me all to result in producing the same chemical compound, an alkaline aurate.

Great hopes were some time since entertained that pictures might be produced with more rapidity, and prove more lasting, if they were developed like an ordinary negative, but this result has not yet been attained on any large scale. In fact, to manufacture them in this manner, we must produce a different class of negatives, those we now employ being much too contrasting in the lights and shadows. For this process we require a negative slightly over exposed, and brought out with iron only, until the details are fully developed. The following formula was partly suggested by Mr. Henry Claudet, and I have found it work very admirably with Towgood's paper ; with albumenized paper I have had no experience. Salt with

Printing by
development.

Present negatives
not applicable.

Description
required.

H. Claudet's
process.

Salting solution.	{	Saturated solution of bichloride	
		of mercury	1 ounce.
		Distilled water	19 "

Excite by floating on

Silver solution.	{ Nitrate of silver	20 grains.
	{ Distilled water	1 ounce.

Then dry and print until about half the details are visible, then develope with saturated solution of gallic acid, slightly acidified with acetic, after which wash until the solution no longer affects a persalt of iron; then tone with

Chloride of gold	1 grain.
Chloride of ammonium	2 „
Distilled water	2 ounces.

Fix and wash as usual.

Vignette
printing.

For printing portraits and small scraps of landscape, where accessories are not required, or where they may be undesirable, the “vignette glass” is very useful: it is a glass coloured so deeply at the edges and some distance in towards the centre as to entirely cut off the actinic rays of light, and this coloration is gradually shaded off until it ceases altogether, leaving an aperture of the size and shape required around the centre. This glass being interposed between the light and the negative, permits the former to pass only through the transparent centre, and gradually cuts it off until it ceases altogether, thus surrounding the picture with a soft halo, which in certain cases, very much improves its appearance.

ON MOUNTING PHOTOGRAPHS.

Being necessarily printed on somewhat thin paper, the pictures require some kind of support; this is given by mounting them on cardboard; the best adhesive substances for this purpose are stiff starch paste or size; but it is not

an easy process for the amateur to effect perfectly, unless he can command the use of a powerful press to keep them from "cockling" while drying. It must not be forgotten that stereoscopic pictures, taken on one glass, in the binocular camera, must be *divided* and *transposed* in the mounting, or the effect is pseudoscopic, more curious than beautiful.

Mounting
stereoscopic
pictures.

REPRINT of a paper communicated to the "Photographic Journal" in 1858, entitled, an Analysis of the material of the image of positive prints, with the mode of recovering the silver and gold from old baths, washing waters, &c., &c., by J. B. Hockin.

MEDITATING some time since on the enormous quantities of both silver and gold consumed in the various photographic processes, and the very small amount recovered from the residuary liquids, I was induced to undertake a short series of experiments, with the view of ascertaining the quantity of those metals concerned in the production of a given number of pictures, the proportion remaining in the same when finished, and how much might be extracted, *economically*, from the various liquids employed in their manufacture.

The following are the results I have obtained, and the deductions which I think may be drawn therefrom.

I prepared six fluid ounces of solution, which, on analysis, yielded me an amount of chloride equivalent to ninety grains of nitrate silver to the fluid ounce. On this I excited, by floating, sixteen papers, 9×7 , Towgood's manufacture, salted by immersion in a twelve grain solution of chloride of ammonium. These absorbed exactly two fluid ounces of liquid. The residue being examined, proved to contain only seventy-seven grains of nitrate of silver to the ounce, thus showing that, independently of the loss in the two fluid ounces, the four

remaining were reduced to the extent of thirteen grains per ounce. The calculation therefore stands thus: six fluid ounces containing each ninety grains, equal 540 grains; minus 308 grains contained in the residue, give 232 grains nitrate of silver used in exciting the paper.

These, after printing, were treated in the following manner:—They were first immersed for four or five minutes each in a solution consisting of hypo' two ounces, water six ounces; washed in a stream of water for one minute, then immersed until toned in a similar solution containing half a grain of chloride of gold to the fluid ounce. No more than six were fixed in eight ounces of the first bath, nor more than nine in the second, for reasons which will appear in the sequel. The quantity of chloride used was twenty grains, equal to ten of metallic gold, as I found that for each picture of that size, at least one grain was required to produce a good purple black colour.

On burning one of the finished pictures, which having been lightly printed was rather wanting in detail, and treating the *cinder* with nitric acid, I was somewhat astonished to find that it gave me a scarcely perceptible trace of silver when tested by hydrochloric acid.

I therefore exposed another paper to the light, without any negative over it, until it became nearly "bronzed"; I then fixed and toned it like the others, washed it carefully, dried, and burnt it.

The cinder was treated with somewhat dilute acetic acid and washed. The liquid yielded no trace of silver. The residue was then acted on by hot dilute nitric acid, carefully washed free therefrom, and the liquors collected. The residue, on being ignited with pure nitrate of ammonia

and washed, left absolutely nothing but pure metallic gold 0.06 grains. The nitric solution, subsequently precipitated by hydrochloric acid, gave the same quantity, viz. : 0.06 grains chloride of silver.

The various hypo' liquids were saved, mixed, and precipitated by a slight excess of sulphide of ammonium ; the precipitate was collected, treated with strong nitric acid in excess, then by aqua regia, evaporated nearly to dryness, and washed with abundance of water. The insoluble remainder, consisting of chloride of silver, was fused and found to weigh 116 grains, which is equivalent to 137 grains nitrate of silver. The liquid filtered therefrom, and treated with protosulphate of iron, deposited 4.60 grains pure gold. Two pictures having been over-printed, acquired fine tones in the gold bath, but the whites were not sufficiently clear ; they were therefore returned to the first bath, wherein six pictures had been fixed ; on the following morning they were found to be perfectly sulphuretted, the whites having become of a deep yellow, but on being floated for an instant on a five-grain solution of cyanide of potassium, the whites were perfectly restored, and the dark colour but little impaired.

From the above facts I draw the following conclusions :

1st. That in using a paper salted with ten to thirteen grains chloride of ammonium to the ounce, it will be necessary to add to the bath three to four grains of nitrate for every sixty square inches floated thereon ; otherwise, after exciting a dozen papers on a bath containing only forty grains to the ounce, it becomes so reduced that the paper is enabled to take up all the silver from the liquid with which it comes in contact. This may very probably

answer a question which has frequently been put lately, and never yet been resolved, viz. : What is the cause of a voluminous curdy precipitate which sometimes occurs in old baths used to excite albumenized papers ? My opinion is, that with a highly-salted albumen and a very weak bath, you abstract all the silver from the stratum with which contact is made ; this, unable any longer to coagulate albumen, dissolves it ; the solution gravitating comes in contact with the silver solution beneath, and becoming coagulated, precipitates.

2nd. The fact that acetic acid dissolved out no trace of silver from the cinder produced by burning a picture, would lead one to infer that only metallic silver was primarily concerned in its production. Had it been the *hypothetical* "black chloride" of some chemists, it would have been found with the gold after perfect ignition of the carbon, which was not the case. Moreover, the relatively small quantity of silver found points in the same direction, silver having in fact become, to a great extent, replaced by gold. The sulphuration of the two pictures left in hypo' contaminated with silver salts is also highly instructive, and although long known, is very generally neglected : *vide* some examples quoted in the "Photographic News" of a short time since, to the truth of which I can myself bear witness. Whether the cyanide, by removing the sulphur in the state of sulphy-cyanide, will arrest the fading of such pictures is a question which only time can decide ; I am disposed to think favourably of it.

3rd. That inasmuch as more than half the quantity of gold and silver employed was extracted from the hypo', I would recommend all photographers to use the means of precipitating them, described below ; also to keep not only

the hypo', but all the first waters used in washing. It would be highly desirable to discover a method of deriving more benefit from the use of chloride of gold. One grain is consumed in doing work represented in the picture by 0.06 grains of gold, equal 0.12 chloride.

4th. If the photographic operator were to carry out the following system carefully, he might recover a very large per centage of the precious metals he now loses :—

The liquids used in developing and washing the collodion plate should be allowed to run from the developing cistern through the waste pipe reaching to the bottom of a tub, placed underneath, the overflow of which takes place at the top ; a little common salt may be added from time to time. It is a noteworthy fact that these liquids, when allowed some time to rest, are totally free from silver in solution, the pyrogallie alone appearing to reduce it. It will however be as well to keep a little salt in the tub, as time is necessary to its full decomposition by vegetable matter. Into this tub no cyanide or hypo' may be admitted. The plates must be fixed in a bath of these, and the washing off conducted at another place. When they become saturated, they may be added to the hypo' liquors and the first wash waters, preserved in a large tub at a distance from the laboratory if possible, and the silver and gold precipitated therefrom by passing a current of sulphuretted hydrogen into them, or by the addition of a solution of sulphuret of potassium, the "liver of sulphur" of the druggist. The various deposits may be collected on a cloth, dried, and reduced by fusion with dry carbonate of potash and soda, or sent to the refiners, who perform the operation for a very small sum.

ADDRESSED

TO THE

PRACTICAL PHOTOGRAPHER.

CONSIDERABLE mis-conception exists as to the best mode of avoiding the loss of the valuable metals employed to such an extent by the working photographer ; I have known an instance of a man who, expecting to get rich suddenly, sent a large bale of toned paper cuttings by rail to the refiner, and was deeply chagrined at getting a balance of five shillings only in his favor, after all expenses of carriage, &c., had been paid, forgetting that he might have burnt the paper himself and thus saved all the carriage ; and again, that his hypo' liquids which he threw away, contained almost all the silver and a great portion of the gold he had employed. It will be my province, in the present chapter, to go fully into the subject of obviating the waste of precious metals usually incurred.

On the economization of refuse silver and gold solutions, &c.

I would advise no one to attempt the reduction of them to the metallic state, unless his knowledge of that branch of chemistry is particularly well grounded, or he resides at an impracticable distance from a respectable refiner.

To commence at the beginning :—

The developing liquids, as they run from the collodion plate, contain a very large proportion of silver, which very soon assumes the metallic condition : they should be allowed to escape from the developing sink through a pipe

The waste liquids from the development

which reaches nearly to the bottom of a tub placed beneath, the efflux from which takes place near the top; in it may be put a little salt from time to time. The liquid which runs away contains no silver, hence may be conducted at once into the sewer. When the deposit attains a thickness of two or three inches, it will repay the labour of removing; it should be turned out on to a cloth and allowed to dry spontaneously. The cyanide liquors should not be allowed to run into the waste tub; in a large establishment it will be well to use a bath of cyanide for fixing the glass plates, adding one per cent. of the dry cyanide from time to time as the previous dose becomes saturated; a large quantity of silver may thus be accumulated in it and precipitated by a soluble sulphide, in the manner to be presently described for the hypo' liquors. Drops of solutions of nitrate spilt about should be absorbed by blotting paper, which, together with that used for backing up the plate in the slide, old filters, cuttings off the excited paper, &c., must be allowed to accumulate, and then burnt to a white ash; the latter only to be sent to the refiner. Nitrate baths or aceto-nitrate, which may have become spoiled by any accident, must be precipitated by the addition of a solution of common salt as long as any effect is produced, the liquid thrown away and the deposit (chloride of silver) washed on a calico filter; if it exists in sufficient quantity, it is well to send it separately to be reduced, as when perfectly dry it contains two-thirds its weight of silver. A considerable quantity may be accumulated in large printing establishments, if the newly-excited papers are allowed to drip into a vessel of salt and water.

Cyanide fixing
bath.

Silvered paper.

Nitrate of Silver
solution.

Drainings of
excited paper.

The largest amount of saving, independently of the reduction of accidentally spoiled silver solutions, (which,

due care being exercised, need never occur,) will be found in the precipitation of the hypo' liquors used in fixing and toning. These should be allowed to accumulate in any suitable vessel of known capacity, until it becomes full, then precipitated by a soluble sulphide; the "liver of sulphur" of the druggist is the cheapest and answers perfectly. The operation should be performed at a distance from the operating room, as the fumes of the sulphide are offensive, and injurious to the nitrate bath. It is well to avoid adding an excess of the re-agent, as it possesses a certain solvent property over the precipitate, (sulphides of silver and gold), and hence loss is occasioned. For those unacquainted with the more delicate chemical manipulations, the following will be the best mode of proceeding.

Treatment of the hypo' liquors.

Necessary precautions.

Weigh out the sulphide into quantities of an ounce each, dissolve one in water, add it to the hypo' liquor, and stir well; it will be seen to cause the deposition of a dense black sediment; when the liquid becomes clear, put in the small portion of sulphide remaining, and note if it causes a precipitate, if it do, add another ounce dissolved as before, and continue these additions and thorough stirring between each until they cease to cause a precipitate. It must then be allowed to settle, the supernatant liquid poured off, and the solid matter put on to a calico strainer, well washed and allowed to dry.

The more chemical will proceed by taking out one fluid ounce only of the liquid, precipitating this carefully with a standard solution containing any known quantity of the sulphide, dropped from a burette, such as my argentometer; the quantity used multiplied by 160, (the number of fluid ounces in a gallon) multiplied by the content of his vessel

The alkaline toning bath.

Mode of reducing
the gold there-
from.

Reducing silver
from its chloride.

Reducing silver
and gold from
the mixed
residue.

in gallons will give the equivalent of sulphide, which he may at once weigh out and give to a boy to complete the somewhat unpleasant operation on the large scale. The "alkaline toning" bath may be separately precipitated in the same manner; the deposit therefrom consists almost entirely of sulphide of gold, and requires only to be heated to redness in a porcelain dish, then washed successively in weak nitric acid, weak hydro-chloric, and lastly ammonia, to be saleable as fine gold. The mode of reducing the pure chloride of silver is very simple, all that is necessary being to put it in contact with an equal weight of ordinary zinc, cover it to the depth of an inch with very dilute sulphuric acid (1 in 100) and leave it undisturbed 24 hours; the residue being washed in common hydro-chloric acid (spirit of salt) is metallic silver almost absolutely pure. If required for re-conversion into nitrate, it must be fused in a crucible with its own weight of carbonate of soda, to which has been added five per cent. each of common nitre and borax. The mixed residues demand a more careful treatment; each must be dried separately, at first spontaneously, then in an iron pan at a moderate heat, then mixed intimately with an equal weight of the following: dry carbonate of soda 60 parts, dry carbonate of potash 30 parts, nitre 10 parts, the mixture put into a lined crucible and cautiously heated in a furnace until it fuses tranquilly. The button of metal found on breaking the cooled mass consists of silver and gold, the latter remains when all the former is dissolved out by an appropriately dilute nitric acid.

ON REMOVING PHOTOGRAPHIC STAINS.

Photography has been called, not inaptly, "the black art," inasmuch as its votaries seldom come out with entirely clean hands. I will briefly describe the method of purging these and eliminating silver stains from linen or woollen garments.

While manipulating, it is advisable to keep near the operator a small basin of dilute hydrochloric acid (one part to ten of water) and to dip the fingers into this after handling the plates, and before washing them ; this will dissolve out the pyrogallie acid or iron acquired from the developer, and convert the nitrate of silver into the more stable chloride.

After the day's experiments are over, a short soaking in the dilute acid, rinsing in water and subsequent treatment with an equally strong solution of cyanide of potassium, will effectually remove all traces of stains. Much alarm has been caused by the assertion that cyanide, applied externally, is capable of exerting a poisonous action, more particularly if the skin be cut or abraded ; having used it personally and had extensive acquaintance with others who have resorted to it daily for a long series of years, without any evil result whatever, I consider that the alarm is quite unfounded ; nevertheless, I must caution the unwary that it is only to be applied to the comparatively hard skin of the hands.

The more delicate cuticle of the face would be dissolved by the strongly alkaline commercial cyanide, and hence irritation may result, but not from any poisonous action ;

this I believe is only produced when the chemical is taken internally, a very minute portion then suffices to cause death. To extract silver stains from the linen, or from black woollen clothes, moisten them first with a liquid prepared by dissolving 20 grains iodine, 40 grains iodide of potassium, in one ounce of water, let rest a few minutes, then treat with solution of cyanide of potassium, (ten per cent.,) finally with water ; colored clothes are best treated with iodide of potassium, omitting the iodine, and much weaker solution of cyanide.

PHOTOGRAPHIC PROCESS

ON

NEGATIVE PAPER.

THIS resolves itself into two distinct heads, viz.: the Calotype or Talbotype, and the waxed paper process ; for the former it is necessary to employ English paper only, of which there are now some excellent varieties in the market ; for the latter, French paper, being sized with starch, is more suited, that made by Canson Frères is the best. In choosing them, it must be borne in mind, that, as the pictures when produced are to be used for printing from, like the pictures on glass in former sections, only such sheets can be employed as do not present any defined grain on being examined by being held between the eye and the light, otherwise the grain would imprint itself upon the positive copies, and in the majority of instances, greatly deteriorate the effect.

THE CALOTYPE.

Various modifications of Mr. Fox Talbot's original method have been devised, the following appears to give the best result. The first and most important step is to produce what is known as iodized paper, i.e., paper on the surface of which is deposited a perfectly even coating of pure iodide of silver ; this is effected either by the "single wash" or by another method, both which I shall now describe.

To iodize paper by the single wash.

Iodizing solution.	{	Moist iodide of silver . . .	83 grains.
		Pure iodide of potassium . .	650 „
		Distilled water . . .	4 ounces.

Order of mixing. Dissolve the iodide of potassium in the water, then add thereto the iodide of silver, and stir until complete solution is effected ; should the silver not entirely disappear, add a few more grains of iodide of potassium, filter it into a clean stoppered bottle, and preserve for use. The moist iodide of silver is prepared by dissolving separately each in four ounces of distilled water, 60 grains of nitrate of silver, and 60 grains of iodide of potassium, and pouring the former solution into the latter constantly kept stirred ; keep up the agitation until the liquid becomes bright, then allow the deposit to subside ; pour off the supernatant liquid, add four ounces more distilled water, again agitate it and allow to subside ; after repeating this operation four times, the precipitate is sufficiently washed, and when drained thoroughly is fit for use as above.

Preparation of
iodide of silver.

This operation should not be performed in a strong light.

Iodizing the
paper.

Mark the smoothest side of your paper in two or more of the corners with a black lead pencil, float each sheet on the iodizing liquid, until it lies quite flat, take it out and suspend to a line by a bent pin or wooden clip ; allow the papers to hang ten minutes or a quarter of an hour, but not long enough to become dry.

Mode of
arranging the
washing.

Having now ready four dishes filled with rain or distilled water, float the paper first prepared, with its face downward, on dish No. 1 for three minutes, thence remove it to No. 2 and place another on No. 1 ; after three more minutes

remove No. 2 to No. 3, No. 1 to No. 2 ; put another on No. 1, and so on until the first paper has passed through the four, when it must be immersed in a large vessel, containing ordinary water ; these operations must be repeated until all the papers, having in their turns passed through all the dishes, have accumulated in the last vessel, where they must be placed in such a manner that the coated surfaces only come into contact with coated and *vice versa* ; they must then be washed with occasional agitation and frequent changes of water, until the fluid, which drops from a sheet taken out, allowed to fall into a measure no longer produces, when tested with nitrate of silver, a precipitate insoluble when a drop of ammonia is added to it, this indicating that every trace of iodide of potassium has been removed by the water ; the washing is completed by placing each sheet separately upon a pine board or slate, and directing a stream of water from the tap, both over and under it for a minute.

How to ascertain when sufficiently washed.

The amateur would do well to purchase this at first, the difficulties attending the manipulation are great, and success in the subsequent processes depends in a great measure upon the washing having been perfectly conducted.

Thorough washing essential.

Thus prepared, the iodized paper will keep in a portfolio for many months.

Another method of iodizing :—

Cyano-iodizing liquid.	{	Moist iodide silver . . .	125 grains
		Pure cyanide potassium, about 100	„
		Distilled water . . .	4 ounces

Add the water to the iodide, and continue adding the cyanide dissolved in very little water, until solution is nearly effected, then filter ; float the paper on this liquid

and hang up as in the former instance, but instead of merely washing it, float it for one minute on

The acid solution.	{	Pure hydrochloric acid	1 part
		Distilled water	40 parts

Care required
in using the
cyano-iodizer.

Thence remove it into a vessel of clean water, and proceed to soak and wash as before. The result in both these instances is the same, but I am disposed to give a preference to the latter process, from many reasons, which however I need not here detail : I must however observe, that in the floating on the acid, prussic acid is liberated, it should therefore only be conducted in a room where free circulation of air is procurable.

To sensitize the iodized paper we employ two liquids.

Saturated solution of gallic acid.	{	Gallic acid	½ drachm
		Alcohol	2 drachms
		Distilled water	6 ounces
Aceto-nitrate of silver.	{	Nitrate of silver	30 grains
		Glacial acetic acid, pure	1 drachm
		Distilled water.	1 ounce

When these are required for use, we take

Sensitizing liquid.	{	Gallic acid solution	10 minims	} Mix.
		Distilled water	1½ drachms	
		Aceto-nitrate of silver	10 minims	
		Distilled water	1½ drachms	

This and the subsequent developing solution should be mixed only at the moment they are required, as they decompose by contact, even without luminous influence ; the measures, glasses and rods must be washed before being again employed.

The gallic acid solution should be made only in small quantities at a time, as it does not keep well ; it can be

Mode of making
gallic acid
solution.

prepared and filtered within a few minutes at any time, by first dissolving the acid in the spirit, adding the water, and filtering. The aceto-nitrate will keep indefinitely and is not injured, nay, is improved by exposure to day-light.

Mode of making
gallic acid
solution.

TO EXCITE THE PAPER

two modes offer themselves, viz.: by the glass rod, or by Buckle's brush, a glass tube with evased ends into one of which some cotton wool is drawn by a string and trimmed so as to form a brush. I prefer the former mode and proceed thus. Having procured a board of white pine wood, a trifle smaller than the paper, I lay on it two thicknesses of blotting paper, its own size, and thereon the iodized paper, face upwards, with the superabundant edges bent downward; I then pour along the rod laid near the left hand edge, as much of the above sensitizing liquid as I judge will well cover the paper, and by several rapid strokes of the rod, cause it to thoroughly wet the whole surface.

Of exciting.

The paper is then removed on to some thick blotting paper, and the superfluous moisture blotted off; and drying completely effected by removal to another fold of blotting; it may then be stored between pink blotting paper, and preserved for use. In hot countries or seasons, the gallic acid solution may be omitted from the sensitizer, and with advantage.

Blotting off.

In hot weather
omit the gallic
acid.

In proportion to the dilution of these liquids will be the length of time the prepared paper will keep between the sensitizing and final development. Failures innumerable arise from too strong solutions. Mr. Talbot's specification of 1849 directs the aceto nitrate and gallic acid solutions

Causes of failure.

to be used without dilution ; in this state it is impossible to preserve them five minutes, spontaneous decomposition is set up even in total darkness. Badly washed iodized paper is very fertile in producing failures, from the remaining iodide of potassium being sufficient to entirely saturate the small proportion of nitrate of silver employed, and thus produce a pure iodide of silver which is unacted on by light. The remedy in this instance is gradually to increase the dose of silver (that of gallic acid remaining constant) until the desired effect is produced.

Causes of failure. is set up even in total darkness. Badly washed iodized paper is very fertile in producing failures, from the remaining iodide of potassium being sufficient to entirely saturate the small proportion of nitrate of silver employed, and thus produce a pure iodide of silver which is unacted on by light. The remedy in this instance is gradually to increase the dose of silver (that of gallic acid remaining constant) until the desired effect is produced.

Time of exposure The ordinary time of exposure in the camera for the paper prepared as above, and a good single lens, with a half inch diaphragm, is about five to seven minutes. It is not advisable to keep the paper prepared beyond twelve hours ; excited in the morning it should be developed the evening of the same day.

TO DEVELOPE,

Process of development.

proceed as in sensitizing, using at first the "saturated solution of gallic acid" only, in order thoroughly to moisten the surface of the paper, then the same mixed with an equal bulk of aceto-nitrate, both undiluted. A properly exposed picture will have but a faint trace of the sky visible on being taken from the camera, this will acquire more vigour under the preliminary treatment with gallic acid, and the high lights will also begin to show themselves, followed in due course by the other portions when the aceto-nitrate is added ; when sufficient intensity has been produced, the action must be stopped by immersion in water, and careful washing under the tap.

It is fixed by immersion in

Hypo' fixing liquid.	{	Hyposulphite of soda	1 ounce
		Warm water	8 ounces

Or,

Cyanide fixing liquid.	{	Pure cyanide potassium	20 grains
		Distilled or rain water	10 ounces

until the yellow colour has entirely disappeared.

Nothing now remains but to soak it some hours in water, frequently changed, to dry it perfectly between blotting paper by means of a hot iron, and wax it to give it the necessary translucency.

The waxing is best effected by strewing the surface with finely scraped white wax, and ironing the proof between two pieces of bibulous paper, then removing it between two similar sheets of paper repeating the process with the iron. The proof will then be ready for printing from.

Mode of waxing.

This process is an exceedingly valuable one, and has, in skilful hands, produced results of great beauty. It enables us also to dispense with daylight in the production of positive proofs in the following manner.

Paper sensitized as above, and dried, may be placed under the negative in a pressure frame, and after being exposed to the light from a good lamp, or a gas-jet for a minute, and developed, gives us a positive of a beautiful black tone, and almost in every respect equal to that obtained on the chloride paper, described in a former section. The difficulties, however, inherent in it, have decided the majority of photographers in favour of the process next to be described.

Printing without daylight.

THE WAXED PAPER PROCESS.

To wax paper, obtain the purest white wax, (that ordinarily kept by chandlers and druggists, containing spermaceti or stearine, is not suitable) and a steel plate, similar to that used for engraving, or even a druggist's pill tile ; heat the plate by a bed of hot sand, or any suitable means, up to 212 or 220 degrees, lay a sheet of Canson's negative paper thereon, and rub a cake of wax over it until it is sufficiently impregnated. Proceed thus until you have produced a sufficient stock. Each sheet is now to be placed between two other sheets of similar paper, enclosed in blotting paper, and ironed with a hot "box-heater ;" any excess of wax will be distributed to the clean sheets, and the centre one be now in a condition to receive its final ironing between blotting paper, (which for this purpose should be a fine sort) to give it uniform transparency.

The supplementary sheets seldom obtain sufficient wax to serve without having some more added ; they therefore may be heated on a future occasion by the hot plate. The remarks appended to the albumenized and iodized paper, relative to home preparation, are here equally applicable.

Iodizing solution.	{	Iodide of potassium	4 drachms	} Mix dry and add thereto.
		Bromide do. .	$\frac{1}{2}$ drachm	
		Pure iodine . .	5 grains	
	{	Grape sugar . .	50 grains	} Dissolved separately.
		Sugar of milk . .	4 drachms	
		Distilled water .	10 ounces	

Solution of pure cyanide of potassium quant: suff.

to decolorize almost entirely may then be added. Many operators replace the water by rice water, or whey of milk. Rice water is made by washing one ounce of best rice thrice with distilled water, pouring thereon a pint of the same liquid, and just getting it to boil, then straining off the liquid ; after reposing twelve hours, strain the clear supernatant portion through fine cambric : whey, by boiling a pint of fresh pure milk, then taking from the fire and stirring in forty minims of pure hydrochloric acid, mixed with half an ounce of water, the coagulum, being then separated by straining through muslin, leaves the whey comparatively clear ; after reposing twelve hours, it may be filtered bright for use.

No more than six sheets 11 by 9 should be immersed in the above quantity of liquid at one time ; before putting in more, the original color must be restored by adding iodine, quant : suff.

Immerse the sheets one after the other in the iodizing liquid, as directed in salting paper, and allow them to soak twelve hours, covering the dish with a glass plate ; when ready to take out, turn over the mass, and having ready a dish containing soft water, pass each sheet through it by immersing one edge and then drawing the paper through ; finally hang them up by bent pins to dry on a line. They are generally tinged a color inclining to purple, and are to be preserved for use in a portfolio.

To SENSITIZE. Float each paper separately on the acetate solution described in a former section, page 108, (having previously marked it to know which side is sensitive.) As soon as all color has entirely disappeared, it is sufficiently impregnated, and may be drawn through water as before, and either blotted off for immediate use,

or dried on a line. As this paper will keep excited several days, or even three or four weeks, it is sometimes convenient to prepare a larger number at once ; this is done by immersing them in the aceto-nitrate, leaving them a quarter of an hour, draining off the liquid, pouring in an equal quantity of soft water, and after repeating this twice, finishing by drawing through clean water singly as before. The washing waters may be saved for use in a future operation.

The sensitiveness and keeping qualities of this paper vary with the number of washings, the more it is washed, the longer it keeps, and is consequently the less sensitive ; those sheets floated and used within a few hours of exciting, are nearly equal in sensitiveness to the calotype paper before described.

They should be preserved between sheets of red blotting paper in a close dark portfolio, pressed as tightly as possible to prevent the access of air, which, in large towns especially, always contains certain sulphur compounds, which will entirely destroy their sensitiveness.

The exposure in the camera with a lens $2\frac{1}{2}$ inch diameter, twelve inch focus, $\frac{5}{8}$ inch diaphragm, in good diffused light, will be five minutes and upward.

When much washed for keeping during a journey, a quarter of an hour and upwards is required. After exposure in the camera, the latter may be kept a considerable time before being developed ; the former twelve hours.

TO DEVELOPE. Plunge the sheets into a saturated solution of gallic acid ; within ten minutes they should begin to give some definite idea of the picture, if they do so, pour off the solution and mix it with an equal volume of the wash waters ; or if there be none, $\frac{1}{20}$ of its

volume of aceto-nitrate ; (that which has been once used for exciting is best reserved for this ;) they must be lifted up from time to time to examine by transmitted light, whether they are sufficiently developed, this they generally are in from one to two hours. The perfect result is known by all the half tones being perfectly brought out, without solarization, (i.e. opacity) of the high lights. If over-exposed, the development will be much more rapid, and will be similar to that before explained in the collodion process. If under-exposed, before the picture has sufficiently come out, the whole surface becomes fogged or veiled by the spontaneous decomposition of the developing liquid.

The development being completed, wash in a stream of water, and fix by immersion in hypo' or in cyanide ; when well washed, dry between blotting paper, and iron to restore the transparency lost during the repeated chemical manipulations.

The same process may be applied to un-waxed paper with an equally good result, but the iodizing must be completed in a much shorter time, (one hour,) and the paper merely blotted off for immediate use, as in the calotype process, from which it differs little.

Extreme cleanliness in all the vessels, and perfect freedom from turbidity in the liquids is essential ; they should all be filtered before use, except the silver solutions, which are best poured off clear, if it be possible. Should the aceto-nitrate require filtering, it will be best performed through a filter which has been already used for a silver salt, and kept in a covered funnel for the purpose ; new paper always imparts some impurity to this liquid, which injuriously affects the keeping properties of the paper prepared therewith.

It is necessary to avoid touching these papers with the fingers, except at the corners, during any part of the process, as they infallibly leave stains.

APPENDIX.

A CHAPTER ON OPTICS, &c.

BY

C. P. SYMONDS, Esq., C.E.

VARIOUS philosophers of antiquity propounded strange and absurd theories on the nature of light and vision, but it was not until the time of Newton that any really useful investigation was made : the experiments of this truly great mind form the beginning of our knowledge on this subject ; since that period others have laboured in the same field, and contributed to our clearer understanding of the nature of light.

It is not my present intention to enter deeply into the science of optics, nor into the theory of light and vision ; but merely to lay before the reader a few remarks on such of their natures and properties as affect photography generally : it would be a fruitless task for me to do so in a paper of the present dimensions, or to enter upon the value of light as an agent in the formation of the gorgeous and varied colours of the flowers of our earth, the sparkling lustre of its gems and minerals, the sublime magnificence of the starry firmament, or the lovely mixture of tints on the cheek of beauty.

By allowing a ray of sunshine to pass through a transparent prism of glass or other material, we are enabled to separate the sunbeam into what appear to be its constituent

parts ; the ray is refracted in its passage through the prism, and if received on a screen placed behind it, is found no longer to be a bright spot, but an elongated band called the *solar spectrum*, and this band consists of seven spaces of different colours in the following order : red, orange, yellow, green, blue, indigo, and violet. These seven colours are distinct and visible, and by admeasurement we find that in a certain sort of glass their respective lengths are as follows, the total length of the spectrum being taken at 360.

Red	45	These lengths vary according to the material of which the prism is composed.
Orange	27	
Yellow	48	
Green	60	
Blue	60	
Indigo	40	
Violet	80	
	<hr/> 360 <hr/>	

The above may be verified by mixing together powders of the various colours, or by painting them on a disc of card and making it revolve rapidly, when a sort of dirty white will be produced ; could we obtain the colours sufficiently pure to match the prismatic tints, the white would no doubt be perfect, but even this rough experiment is sufficient to prove the composition of white light.

During the present century, Sir David Brewster has shown that instead of seven, it is highly probable that the chromatic spectrum consists really of but three colours, red, yellow, and blue, the orange being formed by the overlapping and mixture of the red and yellow rays, and

the green by a similar overlapping and mixture of yellow and blue rays : the question is still undecided, but I believe that the latter opinion will eventually be found correct, and it certainly has the merit of simplicity.

The experiments of Herschel and others have shown that the red rays of the spectrum contain the greatest amount of heating power ; that the yellow rays give the greatest amount of light, and are the brightest and most luminous, hence distinctness and visibility of objects are chiefly dependant on these yellow rays ; and that the extreme violet rays are more particularly efficacious in the chemical action of light on various-bodies, so that it is chiefly with these latter rays that we are concerned in photography, for although the red and yellow rays have some chemical power, it is in so small a degree, compared with the blue, that in practice it is disregarded ; speaking generally, we may therefore consider,—

The red as the heat-giving rays,
The yellow as the light-giving rays, and
The blue (in these we include the indigo and violet) as the
the chemical rays.

On further examining the spectral image produced by the prism, we find that the beam of sunlight first falling on the prism does not continue straight through it, but is bent out of its course before reaching the screen ; this bending (called “refraction,”) varies with each of the three (or seven) colours, the red being the least diverted from its straight course, the yellow more so, and the blue the most, or as it is more properly said, the red rays are the least, and the blue the most refrangible ; this unequal refrangibility of the coloured rays has proved a great difficulty in optical instruments generally, for glass lenses with flat or curved surfaces are in reality prisms of various forms, and decompose a beam of light passing

through them into its constituent coloured rays ; the mode of correcting this by means of two lenses in juxtaposition to form an achromatic lens will be found in most of the elementary works on optics, to which I must refer the reader. Although fair results have been produced in photography with simple non-achromatized lenses, their use is attended with so much doubt and trouble, that they may be considered as obsolete in photography, none but achromatic lenses being now used, notwithstanding their increased price.

The camera obscura for photography, mentioned in page 7, is a dark box with a lens inserted at one end, and a sensitive tablet placed at the other, to receive the luminous image ; the earliest cameras of ancient times were without lenses, the aperture being very small served the same purpose, but for photographic purposes we find in practice that we cannot do without a lens of some form or other : at present opticians have only succeeded in producing lenses with *spherical* surfaces, and in such lenses the image or "field" is not formed on a plane, but on a curved surface ; this is termed *curvature of the field* or *curvature of the image*, and as the plates of glass we use for our pictures are flat, this curvature of the image must be decreased and flattened out at the sides, so as to bring the whole of the pictures into tolerably good focus on a flat plane : again, in taking a picture of a landscape, it generally happens that some of the objects in the picture are far from, and some near to the lens, besides there being others at various intermediate distances, we must therefore have some means of bringing objects at various distances all into focus at once : both of these are effected by the use of a stop, which when properly placed lengthens out

the oblique rays so as to make the field flatter, and also by limiting the diameter of the angular pencil of rays from each point in the view, reduces the indistinctness due to defective focussing.

Spherical lenses are also subject to the imperfections termed *spherical aberration* and *distortion of image*: this latter defect is seen in taking a view of a subject containing horizontal and vertical lines, which lines, at the centre of the field, are correctly represented ; but, at the margin of the image, instead of being straight, they become curved and barrel-shaped. Besides this, the objects near the margin of the field become more crowded together than in the centre, so that the image is really not a true representation of the objects to be pictured. It has been repeatedly asserted that a stop cures distortion, but with our present lenses this is not correct ; the stop is of no use whatever in curing distortion, unless it be placed close up to the lens, when distortion is corrected certainly, but the field then becomes so much curved, that the remedy is worse than the distortion.

Spherical aberration is caused by the pencils of light refracted at the centre and those refracted at the margin of the lens not meeting on the same plane, the central rays being less refracted than the marginal ones ; consequently the rays cross each other, causing indistinctness of image, and the focus of any point is not really represented as a point, but as a disc made up of a series of points, when the lens has a large aperture ; what we call the focus of a point is therefore the place where this disc of light is the smallest, and is termed, generally, *the circle of least confusion*.

Spherical aberration is common, more or less, to all lenses which are portions of spheres, but its amount is dependent upon the form of lens, and upon the size of aperture; the double convex is the worst form, the plano-convex and meniscus much better. A stop, by limiting the diameter of the various pencils of rays from each point, does not get rid of it, but so reduces it in amount that it becomes inappreciable in practice. Certain other forms of lenses would get rid of spherical aberration entirely, but our opticians do not appear to have succeeded in making them.

The most general and simple lenses for photographic landscape work are the achromatic plano-convex, and the achromatic meniscus, with a stop in front of the lens; of these two the plano-convex, with the plane side to the view, gives rather the better definition of image, and the field is pretty flat if the lens be of large diameter, (compared with its focal length), and the stop be properly placed, so as to bring the margin of the lens into use; it must, however, be observed, that by increasing the diameter of the lens, we at the same time increase the distortion as we approach the edges of the field, so that the plano-convex form is not well adapted for views with straight lines near the margin; this, added to the expense and weight of a large lens, have caused it to be superseded by

THE SINGLE ACHROMATIC MENISCUS,

Which with a less diameter, will produce the same sized picture as the plano-convex, but the definition at the margin of the field is not quite so good, and the field is not so flat as in the larger plano-convex; for, with the smaller diameter, the marginal rays fall more obliquely on the

lens, and thus increase the curvature of the image ; the meniscus, however, has less distortion than the plano-convex. If the meniscus be made more concave in the front, the central definition is liable to be made inferior, but we flatten the picture and appear to obtain what is called *depth of focus* ; if the concavity be much increased, the definition becomes impaired all over the picture. The meniscus lenses now in use are but slightly concave on the face, and photographers, as well as opticians, appear to be afraid of deepening this concave surface, perhaps the extra thickness of glass required may be an obstacle, but I am of opinion that it would be advantageous to deepen it more than we find in the almost plano-convex lenses at present furnished to the public.

In using the plano-convex or meniscus lens, the plane or concave side must be turned towards the object : if only a small angle of picture were required, it would be better to place the convex side to the view, as we then get better central definition, but at the same time the margin of the field becomes so inferior as to be useless. In telescopes which subtend but a small angle of view, the convex side is placed outwards to give the best field, but as we require in camera pictures as large an angle as we can get, we must reverse this position of lens and insert a stop ; the image then becomes not so good as before in the centre, but better at the margin, and the loss of light is considerable ; to make up for this loss, we obtain flatness of field and get differing distances into focus ; in fact we draw a sort of balance between the good and bad qualities of the lens, sacrificing a portion of the former and obviating some of the latter, so as to obtain a picture not absolutely perfect anywhere but pretty good all over.

The diaphragms or stops are generally so arranged in the brass mounting of the lenses, that they can only be placed at one unvarying distance from the lens ; this is perhaps the best for a beginner, as the stop cannot be very far from its right place if the optician has been careful to fix the cell for the stops at the best position for average distances and general size of stops. I prefer in practice the stops to be in a shifting tube, so that they can be moved nearer to or further from the lens : this latter mode is very advantageous, but it requires a certain amount of photographic experience, as well as some knowledge of optics generally to know where to place it, as its best distance from the lens will perhaps vary with every view taken on a journey. I consider a knowledge of the stop and its position as one of the things to be carefully studied by all who aim at good pictures ; the tourist sometimes meets with a view in which objects are so placed and illuminated as to require all the resources of his art to produce a really faithful transcript of nature ; in such case a thorough knowledge of the power and value of the stops will materially assist in enabling the operator to obtain a successful result.

The Petzval or orthoscopic lens has its merits much extolled by some and disputed by others ; its advantages are the greater freedom from distortion and the flatter field it produces, caused by the marginal rays falling obliquely on the back lens of the combination, this back lens being concave, lengthens out the oblique rays more than the central ones, and the image is consequently flatter than with a single lens of any form ; the illumination of the picture is very equal all over, but this has been somewhat overrated, as a skilful operator with some knowledge of

optics can get a pretty equal illumination with a single lens by a proper management of the stops. The Petzval gives a larger angle of view than the single lens, but this appears also to have been exaggerated, for a meniscus will give an angular view of about 38 to 40 degrees, and the Petzval will only give about 5 or 6 degrees more than this with good definition unless a very small stop be used,

The disadvantages of the Petzval are its increased expense and the number of its surfaces, causing much loss of light by the six reflections, whereas the meniscus has but two: it is however for certain purposes a great improvement on the meniscus, particularly for copying maps and for architectural views containing many straight lines.

As regards curvature or flatness of the field, I personally have doubts as to whether a flat field is advantageous for landscape purposes generally; in almost all views there are three prominent planes, viz., extreme distance, middle distance and foreground: now, if we focus for middle distance and extreme distance, we can by means of a moderate sized stop get both of them distinct upon the ground focussing glass of the camera; the foreground is in nine cases out of ten the earth we stand upon, whether in the form of paving stones, earth, mud or grass, say for example it is the latter, and we must have the blades of grass in focus to show that it is grass, and not an indistinct hazy smudge; this grass foreground will come into the margin of our picture, and, let us remember, we have already focussed for the distances: now if the field of the lens be flat, the focus of this grassy foreground will not fall on the ground glass, but behind it, because the near proximity of this grass will lengthen out the focus of each point of the foreground, and we shall not be able to get

it in focus at all, without using a smaller stop ; on the other hand, if the field of the image be curved, as it is with the plano-convex or meniscus lenses, this very curvature will assist in bringing the foreground into good focus on the ground glass.

By way of still further explaining my meaning on this subject, I will detail the mode followed in focussing a picture this last autumn in Cornwall.

The nearest object was a parapet wall about five yards off ; then came a foreground of mud and stones running to about two hundred yards off, where stood a row of old buildings, forming our middle distance ; then came another sheet of mud extending to about one thousand yards to a hill covered with fir trees, which hill, at one side, sloped down to the edge of the mud and gave a glimpse of more hills and trees about two thousand yards distant : here we had four chief planes of distance, viz.:

The parapet wall at 5 yards from the camera.

The old buildings 200 " " "

The hill of fir trees 1000 " " "

The extreme distance 2000 " " "

I first put in a large stop about $1\frac{1}{4}$ inch diameter and focussed for the old buildings, pushed in the lens to focus for the hill of fir trees, and then pulled it a little out again to about half this distance, so as to get it about half way between its best position for the old buildings and its best position for the hill of fir trees ; then put in the *working stop*, about half an inch in diameter, and examined on the ground glass the old buildings, the hill of fir trees, and the extreme distance ; a very slight movement of the lens sufficed to get all these three distances at once into good focus, after which the lens was not again moved, but all

the rest was done by the stop. The foreground, as was said above, was a sheet of mud and stones ending with the parapet wall ; for pictorial effect it would have been better without this foreground, for it was very white and shiny from its wet surface reflecting the sky, and a light foreground is by no means artistic ; to leave it out entirely would also have saved much trouble, but it was particularly wanted in the picture to give some idea of the extent of the mud, therefore it must be got in somehow. After focussing, as previously described, this foreground was anything but distinct, in fact its focus was *behind* the ground glass, and it was evidently necessary to give more curvature to the image ; the stop was therefore moved nearer to the lens until the parapet wall began to be in focus ; after which, the stop was moved very gently until I got this foreground and the whole of the picture into focus together. Before taking the picture, I tried the effect of a slight alteration in the position of the lens, but found it was not an improvement : the plate was then inserted and the picture taken.

This lens was a meniscus 15 inches focus and $3\frac{1}{4}$ diameter, made by Hockin & Co., and mounted to my own design ; the picture just described was eleven by nine inches, perfect up to the edge, and had the plates been larger, I believe it would have covered rather more than this.

Owing to the defects inherent in the lenses just described, they cannot be used without a stop, which, by diminishing the amount of light, necessarily occasions a longer exposure to produce a satisfactory effect, hence they are only adapted for *still life*, where rapidity of exposure is not an object. In portraiture it would be impossible for a sitter to keep

one unvarying expression on his countenance sufficiently long for such lenses, and we are therefore obliged to use a combination known as

THE PORTRAIT LENS,

Which, as mentioned in page 3, is a combination of two pairs of lenses separated by an interval of about one-third of the focal length of the front combination; as it can be used without a stop, it gives a very brilliant image, and the field is sufficiently flat in the centre for portraiture generally. The light being refracted through two pairs of lenses, produces less distortion than with a single lens of equivalent focus, but the curvature of the image is much increased, and it cannot be so well flattened out by the stop; besides this, when used with its full aperture, it gives in the central part of the field a great flood of light, which rapidly diminishes to about one-half the intensity at the edges. It is frequently asserted that the portrait combination with a stop is as well (or even better) adapted for landscapes as the single lens; if a small angle of view only be required, as in stereoscopic pictures, this may be in a great measure correct, but for a large angle of picture, and pretty flat field, all in focus, we shall find the single lens the better of the two.

It has been much disputed which is the best position for the stop when used with the portrait combination: the chief point to be considered is, that the stop acts by cutting off some portion of the front lens, and as the centre of a lens is always better than the circumference, we should so place the stop that the available portion of this lens is its centre; therefore it is decidedly wrong to place the stop at some distance before the front lens; if placed

between the two combinations the size of the field is increased, but it still has considerable curvature ; if placed nearly touching the front lens (which I consider the most proper place,) the field is made flatter, but at the same time is rendered smaller by the oblique pencils at the margin falling beyond the circumference of the back lens : each of the two latter positions has its advantages and disadvantages, so that it cannot be said one is better than the other under all circumstances.

The portrait combinations are generally made in sizes termed whole, half, and quarter-plate lenses, and opticians profess that they respectively cover plates of $8\frac{1}{2}$ by $6\frac{1}{2}$ inches, $6\frac{3}{4}$ by $4\frac{1}{2}$ inches, and $4\frac{1}{4}$ by $3\frac{1}{4}$ inches ; now this, if not a piece of deception, is very like it, for they certainly may cover these sizes if a small central stop be used, but the optician never says anything about a stop to the buyer, who, on purchasing a lens, is led to suppose that with it he can take a whole-plate sized portrait ; it is true he can do so after a fashion, for some professional artists actually do take whole-plate portraits with a whole-plate lens, but it may generally be observed that they do not take standing figures, but the sitter must be seated in a particular position, and even then the face and neck only are in good focus, the rest of the figure being considerably out. If the light and other circumstances are favourable, we can sometimes use a stop in portrait work, and in such case it is a great improvement, but this so seldom happens, that we must not reckon upon it in practice. I have always considered the whole-plate lens as adapted for portraits on plates $6\frac{1}{2}$ by $4\frac{3}{4}$, the half-plate lens for plates 5 by 4, and the quarter-plate lens for plates 4 by 3, or in other words, that the present whole-plate lens should be called a half

plate, the half-plate should be a quarter-plate, and the quarter-plate lens called a one-sixth, there is however no chance of this ever being carried out, for the present names have been printed in lists and catalogues sent all over the world, and any alteration would undoubtedly lead to great confusion.

The lens we have just been speaking of is the only one at present used for taking portraits, and was invented nearly twenty years ago by Professor Petzval of Vienna, being entirely the result of a thorough knowledge of optics, combined with high mathematical talent; in this case, science alone having determined the forms and curvatures of the lenses, there remained only to put them to the test of practice, and it speaks most highly of the Professor's scientific attainments to learn that the result was found to come up to the expectations of theory. Nearly all our present lenses are but copies of his work or calculations, no other form of portrait combination having yet come prominently before the public. It does not say much for our opticians that they have made no improvement to speak of in optical instruments for photography : when we consider how Herschel, Rosse, Lascelles, Nasmyth and others have made and polished reflecting specula of other than spherical forms, I am of opinion that our opticians ought to be able to grind elliptical or parabolic lenses ; whenever I have mentioned it, I have been met with the old answer, "It can't be done;" but when one considers the works of the above-mentioned amateurs who were not opticians, one cannot help thinking that the mechanical resources of the nineteenth century, together with the improvements in glass making, ought to produce something better than the old mode of sticking a lens upon a post and grinding it by

walking round and round it ; why cannot it be done by machinery ? Ours is the finest in the world, and is made available for almost everything except lens grinding. I do not look upon lenses with elliptical or other sections as impossibilities, and consider that the formation of them would be the beginning of another era in optical instruments.

ON THE

CONJUGATE FOCI OF LENSES.

BY C. P. SYMONDS, Esq., C.E.

It has been frequently stated in former portions of this work, that the image of an object, towards which a lens is pointed, is formed on the ground glass behind it; and that the position of the ground glass will vary with the distance of the object from the lens. It will now be my care to give a few rules whereby any one of these distances being given, the others may be readily ascertained.

Rule I.—*The distance of an object being known, to find the relative focus.*—First find the “principal focus” of the lens, by focussing the moon on the centre of the ground glass, (using a $\frac{3}{4}$ -inch stop) and measure the distance between the back of the lens and the said centre.

Now focus any comparatively near object and measure the distance between it and the lens.

Divide this latter distance by the principal focal length, and subtract one from the quotient.

Put the remainder so found, as a denominator, and over it place the principal focal length as a numerator ; the

fraction thus formed will express the distance of the image beyond the principal focus, or in other words :

This fraction (in inches) added to the principal focal length, (in inches) will give the distance of the image from the lens.

Example.—Given a lens twelve inches principal focus, and an object eight feet or ninety-six inches distant.

Divide 96 by 12, the quotient will be 8, and deducting one from this, leaves 7 for a denominator, with 12 for a numerator, thus making the fraction $\frac{12}{7}$ or $1\frac{5}{7}$, which added to the principal focus 12, will give $13\frac{5}{7}$ as the distance of image from centre of the lens.

The rule just given refers to single lenses only ; for the portrait combination it is not applicable, and in fact any combination of lenses, with an interval between them, so complicates the subject, that it would be quite beyond my purpose to go into the theory of combined lenses ; but the above rule may be made approximately applicable for a portrait combination, by considering it as equal to a single lens of equivalent power, thus :

Screw the combination into a camera twice as long as the ordinary focus of the lens, and bring an object nearer and nearer to the lens, until the image on the ground glass is exactly equal in size to the object itself ; having obtained this correctly, measure the distance from the image to the object ; one quarter of this distance is the focal length of a single lens, equal in power to the combination ; and the position whence to measure will be midway between the object and the image ; the calculation may then be made by the above rule, this being but an approximation, will not bear any thing like close investigation, but will be found sufficiently near for most purposes.

In portraiture it is often requisite to make the representation of the human face divine cover a certain size on the ground glass for the purpose of being placed in a locket, or in some particular frame, and the operator is sometimes called upon to enlarge or reduce a picture to some certain scale, much time is occasionally lost in moving the camera backwards and forwards, to find the proper distance from the object, and some rule for such purpose is wanted, but it is not easy to give one that will suit all cases, and at the same time bear strict examination for accuracy ; the following will however be a sufficient approximation for most purposes : all that is required to be known is the principal focal length of the lens and the relative size of image and object.

Rule II.—*For making the image smaller than the object,* say $\frac{1}{n}$ th of its lineal size, the principal focus $+ \frac{1}{n}$ th of the principal focus will be the distance of the ground glass from the lens; or in other words, the size of image being a certain fractional part of the size of object, to this fraction add 1, thus making a mixed fraction, multiply this mixed fraction by the principal focal length and it will give the distance of the ground glass from the lens, so that if we want the image to be

Full size, this distance will be 2 times

$\frac{1}{2}$ the size,	„	$1\frac{1}{2}$ times the principal focus	
$\frac{1}{3}$ rd the size,	„	$1\frac{1}{3}$	„ „
$\frac{1}{4}$ th the size,	„	$1\frac{1}{4}$	„ „

and so on in any proportion.

Rule III.—*For making the image larger than the object,* say n times its linear size, the principal focus $+ n$ times the principal focus, will be the distance of image from the lens ; or in other words, the image is to be a

certain number of times larger than the object, to this certain number (whether a whole number or a fraction is no matter) add 1 and multiply the sum by the principal focal length, the product will be the distance of the ground glass from the lens, so that if we want the image to be $1\frac{1}{2}$ times the size, the distance will be $2\frac{1}{2}$ times the principal focus

Twice the size,	"	3	"	"
$2\frac{1}{2}$ times the size,	"	$3\frac{1}{2}$	"	"
3 times the size,	"	4	"	"

and so on in any proportion.

These two rules might have been condensed into one, but I divided them for the purpose of making the matter clearer to those who are not well versed in algebraic notation ; at the same time, I must own that I do not use them myself, but follow another system in obtaining the requisite distance *between the ground glass and the object*, the method is by no means scientific, but very simple and practical, thus :

At a certain distance from the camera I put up a "two foot rule," and after focussing it distinctly, measured the length of its image in inches, dividing this length by 24, (the length of the rule) gave a decimal expressing the relative size of the image to the object at that particular distance ; this I did for various distances, and thus made a table to be stuck with marine glue (or engraved if thought fit) on the cap of the lens, so as to be always at hand for reference : this table for my whole plate lens (Hockin's) is as follows.

RELATIVE LINEAR SIZES, THE OBJECT BEING=1.

ft.	in.	{ from object to image, the size of image is }			1.
At 3	11 $\frac{3}{4}$				
4	4	"	"	"	0.60
4	8	"	"	"	0.44
5	0	"	"	"	0.38
6	0	"	"	"	0.27
7	0	"	"	"	0.21
8	0	"	"	"	0.17
9	0	"	"	"	0.15
10	0	"	"	"	0.13
12	0	"	"	"	0.10
15	0	"	"	"	0.077
18	0	"	"	"	0.062
21	0	"	"	"	0.053

With such a table, a mere glance will tell at once where to place the object to get any particular size required. In portraiture it may be convenient to recollect that the height of a head from crown to chin, is very nearly ten inches, a number convenient for decimal notation.

In landscape photography it is a great saving of time and patience to know at once how far off the camera must be placed to include certain objects and no more; this is generally accomplished by what is termed a view meter, being nothing more than a short tube, which, on looking through it, limits the angle of view to the exact size required: in case the operator purchases one of these very useful little articles, I recommend him to try it himself to be sure that it suits the angle of his camera pictures; the one I use myself is nothing more than a short piece of

common brass tubing about $1\frac{1}{4}$ inches diameter, put into a vice and squeezed up till it was found by trial that it included just the required angle when put up to the eye.

For the purpose in question, I have not seen any thing better adapted than the ordinary view meter just described, but I have been sometimes asked to give a simple rule by which to determine before-hand what proportion the image will bear to the size of object at a certain distance, so that if we know before-hand the size of a building, we can judge how far off the camera should stand to get its image a certain size on the ground glass; and more especially, that when afterwards looking at our finished picture, we may be able to say to an admiring spectator, that the real object was 30, 60, 100, or so many times the size of its representation in the picture; the rule is formed by combining the preceding rules; though not theoretically correct, it is an approximation near enough for the purpose, thus:

Rule IV.—Given Q = the distance from the lens to the object, and f the principal focus of the lens, then $\frac{f}{Q-f}$ will be the fraction expressing the linear size of image compared to the size of the object, or in other words:

From the distance (in inches) between the object and the lens deduct the principal focal length of the lens (in inches); put the remainder as a denominator, and over it place the principal focal length as a numerator; this fraction, reduced to its lowest terms, will give the comparative linear size of image and object.

ON COPYING AND ENLARGING
 PHOTOGRAPHIC PICTURES,
 BY MEANS OF THE CAMERA,
 AND ON MICRO-PHOTOGRAPHY.

AFTER a careful perusal of the two foregoing chapters by Mr. Symonds, the principles involved in the operations designated in the heading will be very evident, in practice certain modifications of the usual apparatus and processes are required.

Stereoscopic transparencies are much sharper when produced through the aid of the camera than by superposition. For this purpose a quarter-plate camera is required, having twin lenses with appropriate stops, and a length equal to twice their principal focus. Let the negative be developed with iron, as described at page 50, and be full of detail without any violent contrasts; place it in the dark slide in the exact position which it occupied when taken; to the front of the camera adapt a box of similar size, form, and length to the camera itself, and equally furnished with focussing glass and dark slide and a diaphragm down the middle, then allow the light from the sky, or sunlight, (not direct but reflected from a white screen) to fall on the negative and pass thence through the lenses on to the prepared plate; the operation may also be conducted by artificial light, using the lamp and apparatus to be presently described.

In enlarging pictures several times linear, the following mode of proceeding will be the most simple. Construct a rectangular box, equal in depth and width, and capable of taking the largest sized picture determined on ; the length will depend upon the latter datum and the focus of the lens, as vide table, page 134. The top of the box should consist of a hinged lid, shutting down quite light-tight; the box must be supplied with the usual slide and focus glass, carriers for the various sized negatives, and a diaphragm having a quarter or half-plate lens passing through its centre ; the interior must be furnished throughout with grooves of an uniform size, so that these pieces may be placed in any relative position to each other. It will be evident from the above table, that when the lens is midway between the negative and the prepared plate, the pictures will be equal in size; when nearer the negative, the positive will be increased in size, in proportion to its proximity. In practice, it is advisable not to enlarge a picture too suddenly, two or three diameters at one operation will be found sufficient ; this can be repeated until any desired size is attained, always remembering that the negative produces a positive copy and vice-versa. A good method of sensitizing a very large plate, when a sufficiently large dipping bath is not at hand, is to construct a flat plate glass dish, having one end considerably deeper than the other ; if the dish be tilted with the deep end downwards, it will form a well or reservoir, into which the silver solution may be poured, and then made to flow over the collodion plate (previously placed in the dish) by restoring the latter to a level position.

Microscopic Photography separates itself naturally into two divisions, viz.: enlarging microscopic objects to three

or more inches in diameter, and reducing photographic pictures to microscopic dimensions; and, as they are both practicable by artificial light, this application of photography is well worth the attention of those who possess a good compound microscope.

To enlarge microscopic objects.—Take out the eye piece of the instrument, unscrew and remove half of the “body,” if it be divisible; if not so, one must be made for the purpose, not more than four inches long, or it will interfere with the cone of rays; adapt to the lens flange of a half or whole plate camera a thick disc of brass, through the centre of which pass a tube, lined with velvet, and large enough to admit the body of the microscope; on to the latter you screw the $\frac{1}{2}$ inch or $\frac{3}{4}$ inch object glass, and into the substage you fit an inch power to serve as an achromatic condenser; the best light I have yet seen is the Patent Paraffine Oil Lamp with a flat wick; this must be placed with the luminous portion of its flame at about two or three inches from the condenser, the focus glass being now drawn out to about 12 or 15 inches, and a transparent object placed upon the stage, the apparatus is ready for action. While the plate is being sensitized, you obtain the focus upon the ground glass by means of the usual stage adjustments, and when the focus appears sufficiently sharp to the eye, a picture may be tried; if it does not come out as sharp as the focus (which is very likely to be the case) it will be necessary to make a correction for want of achromatism in the lens, by bringing the object somewhat nearer the lens (microscopes being over corrected, throw the actinic rays somewhat beyond the visual.) This correction will perhaps vary with every lens, but being once ascertained, it will not vary, the distance of

image and source of light remaining constant. Mr. Shadbolt found that a

$1\frac{1}{2}$ inch	Smith & Beck's object glass required			
	two turns of fine adjustment	„	„	$\frac{1}{50}$ inches.
$\frac{2}{3}$ inch	do.	do., $\frac{1}{2}$ turn,	„	$\frac{1}{200}$ „
$\frac{4}{10}$ „	do.	2 divisions,	„	$\frac{1}{1000}$ „
$\frac{1}{4}$ „	do.	„	practically no correction.	

The production of a micro-photograph (properly so called) is the reverse of the above operation, and the essentials are a good compound microscope with a substage; the lamp above described, furnished with a concave mirror behind it, and a plano-convex lens not less than three and a half inches in diameter, which may be screwed into the lens flange of a half or a whole plate camera, with its convex side turned towards the lamp. The negative *picture* should not exceed the dimensions of the bull's eye lens, and should not present too violent contrasts of light or shade. Those produced as advised at page 50 are well suited for this operation; the glass on which it is may be supported in the slide belonging to the camera, and fixed in by means of pins or any other suitable method, at about 8 inches distance from the bull's eye. The position of the apparatus will require slight modifications according to the picture to be copied; but the following directions being attended to, no important alterations will be required.

The microscope must be furnished with a glass holder to prevent the wet collodion plate from injuring the stage, and a strip of glass collodionized, sensitized, well washed, and dried, to serve as focussing glass, and have an object glass of the required power screwed into the substage, which must then be carefully centred. The body of the

microscope (furnished with a half inch or an inch object glass) must then be turned over to a horizontal position, and the whole instrument raised on a block, so that a line drawn through the axis of its lenses passes through the centre of the negative and of the luminous portion of the lamp flame : care must also be taken that the planes of these are at right angles with the said line.

All being so far arranged, the lamp, with its concave mirror behind it, is to be placed at such a distance from the bull's eye that its rays may be rendered parallel on passing through the latter, and thus produce equal illumination of the negative.

The process of taking the picture is in no way different from the ordinary. A slip of plate glass is to be coated with somewhat dilute collodion, (perfectly free from structure) sensitized, and placed with its face towards the lens *screwed into the substage*, the focus having been previously obtained upon the dried coated slip. The exposure will be several minutes, varying of course with the intensity of the light. The development is to be effected with pyro', the picture well washed and dried, and then defended from injury by being covered with Canada balsam and a disc of thin microscopic glass as is usual for transparent objects.

ON CHEMICAL MANIPULATION.

Among the unlearned of my readers there may be some whose acquaintance with chemical terms is not profound ; for the benefit of these I shall endeavour to explain such as I have made use of, taking them in an alphabetical order.

ARGENTOMETER, vide precipitation.

BOILING of fluids for photographic purposes should be conducted only in glass or porcelain vessels, ordinary earthenware being highly porous, must not be used. The best mode of applying the heat is to support the vessel on a wire tripod or the ring of a "retort stand," placing below it a spirit lamp or a wire gauze gas burner.

DISTILLATION of volatile fluids requires to be effected with great caution, to avoid the explosion which must occur if their vapors come in contact with the source of heat. *Æther* may be distilled from a retort having its bulb immersed in a vessel in which water is kept at the boiling temperature, having some straw interposed to prevent the bulb of the retort from touching the other vessel: the best condenser is that known as "Liebig's condenser." The same remarks apply to the distillation of alcohol ; but the addition of some salt to the "water bath" is necessary to insure a sufficiency of heat for rapid distillation.

Water may be distilled from a metallic vessel, but as spring water always contains both gaseous and fixed impurities, about one-sixth of the distilled product must be

allowed to escape before beginning to collect any for use, and the distillation discontinued when not quite two-thirds of the whole have passed over. Pure distilled water is not rendered turbid by a drop of solution of acetate of lead, chloride of barium, or nitrate of silver, (N.B. the bath solution must not be used for this purpose, as that precipitates on dilution,) with the latter re-agent there should be no discoloration on exposure to sunlight.

DECANTATION is the pouring off the liquid from a precipitate or deposit which may have occurred.

FILTERING is an operation to which we have very frequently occasion to resort, it should be avoided as much as possible when silver solutions are concerned. Chloride of gold must not be filtered through paper. It must be recollected that the process is only capable of separating suspended matters, those actually in solution are unaffected by it. Collodion cannot be filtered, and albumen, however dilute, is best clarified by deposition; when alkalized with ammonia it keeps for any length of time. The purest filter paper is known as "Swedish," but is not required for photographic purposes, the best white blotting paper of commerce answering every purpose: colored filter papers are to be avoided. To filter effectually, the filter must be "crimped," the liquid poured in, and not allowed to pass into the vessel intended to finally receive it, until it passes perfectly bright; with very turbid liquids this does not take place for some time.

HEATING; the same remarks apply here as in boiling.

HYDROMETER is a spindle shaped instrument used for taking the specific gravity.

LAMP; see DISTILLATION.

MEASURING. Fluids are generally measured by the

imperial gallon of 70,000 grains weight of distilled water, which is divided into eight pints of twenty fluid ounces each; hence a fluid ounce of distilled water, at 60 degrees Fahrenheit, weighs $437\frac{1}{2}$ grains, equal to one ounce avoirdupois, which is the weight by which all solid goods are sold in quantity; thus, an ounce of nitrate of silver weighs $437\frac{1}{2}$ grains, and not 480 as is universally expected, they constitute the troy or apothecaries ounce, which is used on account of its divisibility into eight drachms of sixty grains each: the avoirdupois ounce is practically divisible only into halves and quarters, and when ounces of solids are mentioned in this work, this is the ounce intended.

NEUTRALIZATION has been sufficiently described in treating of the manufacture of the nitrate bath, pages 25, 26, and 27.

Neutralization is resorted to when a liquid possesses a too strongly marked acid or alkaline reaction, this is evinced by its quickly changing the color of a piece of litmus paper immersed in it. There are some who have put it on record that "reliance is not to be placed upon litmus paper." Alas for chemistry when its votaries and would-be-exponents repudiate one of the "sheet anchors." If proper precautions be observed in its manufacture, (these will be explained under the head of litmus in the next section) it is the only means of ascertaining when the bath has become acid or alkaline, but it must not be used in an ignorant or impatient manner: dipping a piece into the liquid or putting a drop on the paper is not sufficient, it must be immersed and shaken up for some time in contact with it, and watched from time to time; daylight is also essential to the success of the operation.

The experiment being properly conducted, any one may detect $\frac{1}{100}$ drop of nitric acid or ammonia in a pint of fluid ; the reaction with acetic acid in excess is not reliable, neither does the paper give proper indications with anhydrous fluids, such as dry æther, or absolute alcohol, hence perhaps the errors above mentioned may have originated. I must again remark, that test paper is of no use where carbonic acid is evolved in the fluid under examination.

PRECIPITATION is resorted to in order to obtain certain materials in the solid condition, or to eliminate certain matters from a solution where their presence is not desirable : in order to effect it thoroughly, both re-agents must be in solution, and one added in small quantities at a time to the other, with violent agitation of the liquid between each addition, until it ceases to produce any effect. The deposit or precipitate is washed first by decantation, then turned on to a paper filter or calico strainer, and washed by affusion. This process is turned to valuable account in ascertaining the amount of silver in the collodion bath. Taking into consideration the absolute insolubility of chloride of silver in water, or somewhat dilute nitric acid, and its very ready separation from the latter fluid, a solution of pure dry chloride of sodium is prepared of a certain strength, a drachm of the solution to be tested is mixed with an equal bulk of pure nitric acid in a stoppered bottle, and the solution of salt is dropped carefully into it from a graduated tube, with strong agitation between each addition, until it ceases to produce a precipitate; the amount of silver present is then read off on the argentometer, it being graduated to this intent by the maker.

SOLUTION of a solid body in a fluid is much facilitated by agitation and heat, it is never necessary to

resort to the latter in the photographic operations I have described. The more ponderous agents, such as hypo' and common salt, are readily dissolved by crushing them in a mortar, covering them with water and pouring off the fluid when saturated, then adding more until all is dissolved. Materials to be dissolved in æther or alcohol should, if existing in large crystals, be first rubbed down to a powder, then put with the solvent into a stoppered bottle and shaken until they dissolve; micaceous crystals (such as iodide of cadmium and pyrogallie acid) and stellar (such as gallic acid) require no preliminary crushing.

SATURATED SOLUTION is one where the menstrum has taken up as much of the other body as it can possibly: the solubility of bodies varies infinitely, some are soluble in half their weight of water, as nitrate of silver, some to the extent of only one per cent., as gallic acid; their solubility in water moreover gives no clue to that in alcohol or æther; pyroxyline is only soluble in a mixture of the two. Heat also has a great effect in promoting solution, and in the quantity a liquid will take up, the excess is deposited on cooling; advantage is taken of this property of bodies in order to procure them in the crystalline condition. Common salt is one of the rare exceptions to this rule, it being equally soluble in water at all temperatures. When a chemist speaks of a saturated solution, at the ordinary temperature is understood; and, if not otherwise directed, it will be an aqueous solution.

SPECIFIC GRAVITY is ascertained by the use of the hydrometer, a spindle shaped instrument with a weighted bulb at the bottom, which is made to float in the liquid to be examined, or by means of the "specific gravity bottle." Inasmuch as all fluids expand with heat, hence occupy

more relative space, (become lighter), we take all our gravities at the temperature of sixty degrees Fahrenheit, and they are all referred to the weight of distilled water, which represents unity 1.000.

Inorganic bodies which are soluble in water, and contain none in their constitution, dissolve in water without increasing its bulk, hence the specific gravity of the resulting solution will give the quantity of solid existing in it; thus, if I find on testing a solution of nitrate of silver, that its specific gravity is 1.250, I know at once that each fluid ounce contains 120 grains of the silver salt; this would appear contrary to my observation, page 29, that the "argentometer used to test the silver bath must not be an hydrometer," but this is not the case. For every equivalent of silver abstracted from the bath, an equivalent of potassium, cadmium, or other element is added to it, and thus the hydrometer only gives the difference between the atomic weights of these bodies; all the silver might be abstracted, and yet the hydrometer would indicate a fair amount of specific weight.

The method of making an observation with the first instrument, is to carefully lower it into the fluid until it will sink no more, and then read off on the graduated scale the number which corresponds with the level of the fluid. The gravity bottle is first counterpoised in a good balance, then filled with the fluid, and again counterpoised by weights numbered in grains; this is the more delicate instrument, but requires that the balance be a very good one and that the manipulator possess some amount of practice.

TEMPERATURE is ascertained by means of the THERMOMETER, which, for our purposes, should be

entirely of glass, the scale included ; the latter is, after Fahrenheit's system, an arbitrary division of the distance between the temperature of melting ice and water boiling in a metallic vessel at the level of the sea, and at the barometric pressure of 30 inches of mercury, into 180 degrees ; the first being 32 degrees and the last 212 degrees : the zero of our scale is the temperature produced by a mixture of snow and salt. The French system, (the centigrade) is much more rational, between the freezing and the boiling point they make 100 degrees.

WASHING OF BOTTLES, &c., has not an heroic sound ; but I should augur favourably of the photographer who can well perform this important operation. The first thing to be done is to remove all (what may be called) mechanical impurities by means of the bottle brush and plenty of water ; then, if a crust still remains, it must be removed by suitable chemicals. Iron stains are known by their red, ochreous colour, and are removed by hydrochloric acid ; silver stains, if they resist strong solution of cyanide, will be immediately removed by nitric acid, diluted with two parts of water ; this reagent is the best for removing the crust which accumulates in bottles in which "old hypo" liquors" have been kept ; organic impurities are all charred and dissolved by oil of vitrol. After the chemical contaminations are removed, the bottle must be thoroughly rinsed with abundance of water, and finally with pure water. If to be used for containing collodion, aether, &c., they must receive a final rinsing with alcohol, or be thoroughly dried ; the latter operation is not so easy as it appears. I will describe it. Rinse the bottle with alcohol, then heat it moderately hot, and blow into it through a glass tube until it is almost dry ; then draw air

through it by inhaling through the tube. It is absolutely essential that the bottle intended to contain amber varnish should be dried in this manner.

The so-called porcelain dishes, being highly porous, should be each kept for the operation for which they were first used, as they can never be thoroughly cleansed; those used for developing paper pictures are best cleansed with cyanide; they should never be employed a second time without the removal of the deposit of silver which takes place on them, as this will occasion fogging, by decomposition of the developer when mixed with silver.

The same remark applies to measures in which silver is to be mixed with a developing agent; if the latter be much scratched internally, they will frequently induce the decomposition of a developer mixed with silver.

ON

PHOTOGRAPHIC CHEMICALS:

THEIR MANUFACTURE, AND THE MEANS OF TESTING
THEIR PURITY, &c.

IN order that my readers may derive the full amount of instruction I intend to convey in the following arrangement of the chemicals, it will be necessary for me to make a few preliminary observations upon the letters and figures which are appended to the name of each.

It has been ascertained that, notwithstanding the almost infinite number of substances with which we are acquainted, the most complex is the result of the union of five or six only of the really elementary bodies, the ascertained number of which, at this moment, is only about sixty. It has been also proved by the most careful experiment, that each of these combines with another in one certain ratio, which is called the "equivalent" of that body; thus, if hydrogen be taken as unity, oxygen will be as eight, silver as 108. The equivalent of a compound body will be the sum of the equivalents of its constituents. This must be remembered, as it will be of great value when we desire to produce other bodies from the union of two or more. I cannot refer to a better example than the production of iodide of silver, page 106. Our object there is to produce a known weight of the material in the moist condition, consequently we can only do it by calculation.

Very early in our chemical experience we learn that silver has a great affinity for iodine, and precipitates with it from any aqueous solution wherein the latter exists as an iodide. Now this is our plan of proceeding. We first turn to the article, "nitrate of silver," and find that its equivalent is 170, then to "iodide of potassium," whose equivalent is 166·5, this gives us the proportions in which it will be necessary to combine them, provided they are both absolutely pure. Nitrate of silver is generally so, the iodide may not be so perfectly pure or so carefully dried, we therefore take equal parts and calculate that as the equivalent of silver is 108 (out of 170 nitrate), and of iodine 126·5, (out of 166·5 iodide); the proportion of iodide of silver produced will be $234\cdot5 = 108 + 126\cdot5$.

The "elements" are distinguished by the capital letter of their Latin designation, with a smaller appended when a second happens to possess the same initial. Thus nitrogen is N, sodium (natronium) Na. Attached is a table of the elementary bodies with their equivalents, as adopted in the translation of Leopold Gmelin's elaborate work in course of being published by the Cavendish Society, 13 vols., (averaging 500 pages) of which were in print at the end of the year 1859.

TABLE OF ELEMENTARY BODIES, AND THEIR
EQUIVALENTS.

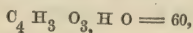
Element.	Symbol.	Atomic weight, combining proportion or equivalent.
Oxygen.....	O	8
Hydrogen.....	H	1
Carbon.....	C	6
Boron.....	B	10.8
Phosphorus.....	P	31.4

Element.	Symbol.	Atomic weight, combining proportion or equivalent.
Sulphur	S	16
Selenium	Se	40
Iodine	I	126.4
Bromine	Br	78.4
Chlorine	Cl	35.4
Fluorine	F	18.7
Nitrogen	N	14
Potassium	K	39.2
Sodium	Na	23.2
Lithium	Li	6.4
Barium	Ba	68.6
Strontium	Sr	44
Calcium	Ca	20.5
Magnesium	Mg	12.7
Lanthanum .....	.....	36.1
Cerium	Ce	46.3
Didymium .....	.....	.....
Yttrium	Y	32.2
Erbium .....	.....	.....
Terbium .....	.....	.....
Glucinum	G	17.7
Aluminium	Al	13.7
Thorium	Th	59.6
Zirconium	Zr	22.4
Silicium	Si	14.8
Titanium	Ti	24.5
Tantalum	Ta	185
Niobium .....	.....	.....
Pelopium .....	.....	.....
Tungsten (Wolfram)	W	95
Molybdenum	Mo	48
Vanadium	Va	68.6
Chromium	Cr	28
Uranium	U	217
Manganese	Mn	27.6
Arsenic	As	75.2

Element.	Symbol.	Atomic weight, combining proportion or equivalent.
Antimony (Stibium).....	Sb	129
Tellurium.....	Te	64
Bismuth	Bi	106·4
Zinc.....	Zn	32·2
Cadmium	Cd	55·8
Tin (Stannum).....	Sn	59
Lead	Pb	103·8
Iron	Fe	27·2
Cobalt	Co	29·6
Nickel	Ni	29·6
Copper	Cu	31·8
Mercury	Hg	101·4
Silver	Ag	108
Gold....	Au	199
Platinum	Pt	98·7
Palladium	Pd	53·4
Rhodium	R	52
Iridium	Ir	98·7
Osmium	Os	99·6
Ruthenium	Ru	51·7

In accordance with the opinion of those who hold that all bodies are multiples of hydrogen, it is usual somewhat to modify many of these numbers : e.g., gold is generally taken at 200, mercury 100, copper 32, chlorine 36, &c. where the decimal is under ·5 it is always omitted in practice.

ACETIC ACID.

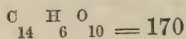


The anhydrous acid is not commercially procurable, the strongest obtainable, viz., that with one equivalent of water, (as per formula above), remains crystalline at 60 degrees, and contains 15 per cent. of water : an acid only

about 5 per cent. weaker is the more appropriate for photographic purposes, being more readily procurable, and much cheaper; the trifling difference in strength is quite unimportant; the term "glacial" is still applicable to the latter, as when once frozen it remains solid at 50 degrees. The latter is obtained by distilling 50 parts oil of vitriol with 82 parts dry acetate of soda, the former by exposing the distillate to cold until it freezes, and then separating what remains solid at a temperature of sixty.

It should not exhibit any marked nauseous odour when mixed with ten times its bulk of water, and should not become milky on being treated with solution of nitrate of baryta, or nitrate of silver, showing absence of sulphuric and hydrochloric acids. Any sample not becoming colored when mixed with the latter reagent, and exposed to light, may be taken as of a very fine quality. It should evaporate entirely when subjected to heat, without leaving a residue. It is impossible to ascertain the strength of this acid by its specific gravity, as after passing a certain strength it gradually decreases in density, nor will test paper show when the point of saturation with an alkali has been reached.

GALLIC ACID.



Is obtained by exposing powdered galls made into a paste with water, to spontaneous fermentation in a warm room for many weeks, by which means the tannic acid originally existing is converted into gallic; this is extracted by percolating the mass with hot water, whence it crystallizes out on cooling: it is purified by repeated solution in hot water and crystallization. It requires for solution three

parts of boiling and 100 parts of cold water, and is very soluble in alcohol, it should burn away without residue on a piece of platinum foil heated to redness.

PYROGALLIC ACID

as has been before mentioned page 31, is produced when perfectly dry gallic acid is carefully heated at about the temperature of 400 degrees. I have never met with an adulterated specimen, but there are great differences in commercial samples, the best is in fine nacreous scales, and possesses no tendency to clot ; it must be preserved in a perfectly clean stoppered bottle, out of reach of ammonia, which speedily blackens it, as do many kinds of glass, owing to an exudation of a portion of their alkali ; this however takes place only very superficially. Solutions of these two acids should be made only in small quantities, and not used as developers after they have become colored.

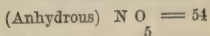
HYDROCHLORIC or MURIATIC ACID.

(Dry) $\text{H Cl} = 36.4$ —is gaseous.

The fluid acid of commerce is obtained by acting upon common salt with oil of vitriol and condensing the gas which comes over in water ; it varies much in specific gravity, consequently in strength ; when of the density of 1.145 it contains about 30 per cent. of hydrochloric acid gas. The commercial acid is very impure, containing iron, arsenic, sulphurous and sulphuric and nitrous acids, chlorine, &c. For photographic purposes it should be pure, if not to be purchased in this state it must be purified ; but I must refer the reader to a text book of chemistry, such as Fownes' Manual, (Churchill) as there are many precautions required in the operation, which would occupy too

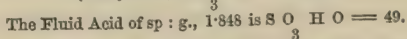
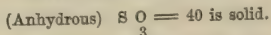
much space here to describe. Mixed in the proportion of three measures with one of nitric acid, it constitutes "aqua regia" used for dissolving gold and platinum.

NITRIC ACID.



The strongest acid commercially procurable is of specific gravity 1.517 and is monohydrated, that is, it consists of one equivalent of real acid, (54 parts) and one equivalent of water, (9 parts) hence its equivalent is 63. A much more readily procurable acid is of sp : g., 1.425, as recommended for the preparation of pyroxyline, page 17. A stronger acid is reduced to this gravity by heating, a weaker by similar treatment loses water and attains this density; it is produced by acting on nitrate of potash or soda with strong oil of vitriol and collecting the distillate; as obtained in commerce it is rarely free from colour, due to its containing some nitrous acid; but this for photographic purposes is unimportant, except as it increases the density (vide page 19). It may be sometimes slightly contaminated with sulphuric acid, owing to carelessness in the manufacture: this is ascertained by solution of nitrate of baryta causing a precipitate in the acid diluted with four parts of water; but the most frequent and dangerous impurity is chlorine, which renders it unfit for making pyroxyline. If a solution of nitrate of silver causes a precipitate in the above dilute acid, it must be rejected.

SULPHURIC ACID.



The commercial article is seldom of this gravity, but contains about five per cent. more water. It is somewhat

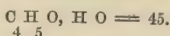
difficult to obtain pure, nor is it wanted in this state for our purposes. Its contaminations may be chlorine, nitric acid, arsenic, lead, &c.; of these only the chlorine is important: this and a colouration, due to its being contaminated with organic matter, must lead to the rejection of such samples.

This acid and the two previous are distinguished as "the strong acids," and require much care in handling, especially while hot; they are corrosive of the skin and all fabrics; even when dilute, if dropped upon the clothes, they eat them into holes, unless immediately neutralized with ammonia: nitric acid indelibly stains yellow the skin, and woollen and silk fabrics.

ÆTHER



ALCOHOL



The adaptation of these for our purposes has been treated on page 22. The latter is, as is well known, produced by the fermentation of saccharine liquids; the former is obtained by acting upon it and abstracting the water by the aid of sulphuric acid, then distilling

AMMONIA.



evolved from a salt of ammonia mixed with slaked lime is conducted into water in which it is very soluble, and then constitutes the "liquid ammonia" of commerce, which is met with of two strengths sp : g. .960 and .880 : the former is the more stable. It is sometimes found slightly contaminated with a chloride, this is fatal to its employ-

ment; it is detected by adding pure nitric acid, more than sufficient to neutralize, and then testing with nitrate of silver.

AMMONIUM

$N H = 18$ is hypothetical.

$Bromine Br. = 78$, $Chlorine Cl. = 36$, $Iodine I. = 126.4$

Are three elementary bodies possessing many properties in common. The first is fluid, the second gaseous, and the last solid at ordinary temperatures. They are by no means pleasant to operate with when uncombined, as they all produce irritation of the mucous membranes of the throat and lungs. Their compounds are all important in photography. Those with the metals, which are soluble, are formed in the case of Br. and I. by putting them in contact in presence of water, taking care not to allow the temperature to rise too high. Compounds with alkalies are made either by precipitating the metals from these compounds by the appropriate alkali or by saturating the latter with hydro-bromic or hydriodic acid, made by passing a current of hydro-sulphuric acid (sulphuretted hydrogen $= H S$) through water containing the element. The chlorides are made by the action of hydrochloric acid upon the metal, or the alkali or its carbonate. The most important of these compounds are the iodides, and of them the iodides of potassium, ammonium, and cadmium take the first rank. I shall make a few remarks upon them.

IODIDE OF POTASSIUM

$K I = 166.$

is a salt which crystallises in cubes free from water, but is very difficult to obtain pure ; in fact, when perfectly free from the small trace of carbonate which is added to it (for the purpose of causing it to keep) by the manufacturer, it

speedily colours on exposure to the light and becomes unfit for iodizing until it has been heated to expel the free iodine.

Its most serious contamination is chloride of potassium. This is detected by dissolving 10 grains in $\frac{1}{2}$ oz. pure water, adding thereto a slight excess of nitrate of silver (similarly dissolved), then agitating until the liquid becomes perfectly clear ; the precipitate must then be turned out on to a filter and thoroughly washed with distilled water ; it is then to be treated with ten minims liquid ammonia, and $\frac{1}{2}$ oz. distilled water. The iodide of silver is perfectly insoluble in this menstruum, which however dissolves any chloride and allows it to precipitate again on being neutralized with pure nitric acid. It is easily manufactured of almost absolute purity by deflagrating (by touching with a red hot iron) an intimate mixture of two parts pure cream of tartar, and one part pure nitre, and heating the resulting black mass to redness in a porcelain capsule. The residue treated with water yields carbonate of potash, which, on being exactly neutralized with solution of hydriodic acid, and evaporated to dryness, will produce pure iodide of potassium.

Iodide of iron is made by taking an equivalent of iodine (see table) and rather more than one equivalent of fine iron wire, and shaking them well together in a flask containing at least ten times their bulk of water or alcohol, until the liquid loses all trace of red colour. In making any quantity, it is well to add the iodine by degrees, allowing the liquid to become decolorized between each addition. This solution will not bear evaporation, and speedily decomposes, unless a coil of the iron wire be kept in the bottle. It has been tried extensively as an iodizer and

accelerator, but without good effect. It is a very convenient source whence to produce the iodides of the alkalies by double decomposition, but I prefer using the hydriodic acid; the salt made from the iodide of iron always retains some of the oxide of the metal, unless it has been evaporated to dryness, re-dissolved, filtered and re-crystallized.

Iodide of ammonium of commerce is most generally made by acting upon iodine with sulphide of ammonium; thus made it is useless as an iodizer as it always retains some sulphur compound.

It should be made by neutralizing pure liquid ammonia, or its carbonate, by hydriodic acid, evaporating to dryness and preserving in small glass tubes hermetically sealed. For the method of decolorizing it when to be used as an iodizer see page 23.

Iodide of cadmium is made like iodide of iron, using the metal granulated instead of in wire. It is found of absolute purity in commerce—in beautifully white nacreous scales—if at all coloured it should be rejected. It is perfectly soluble in alcoholic æther. It possesses the peculiar property of remaining undecomposed in the presence of collodion, and restraining, or altogether preventing the tendency every other iodide has to eliminate its iodine under the above circumstances.

Iodoform is a very curious organic iodide, a congener of chloroform and bromoform, the former of which is now so well known as the valuable anæsthetic, and to the photographer as the solvent for amber. A debt of gratitude is certainly due to Dr. Dymond for the introduction of amber varnish.

Iodoform is made by adding one part of iodine in successive portions (waiting for complete decolorization between each addition) to two parts of crystallized carbonate of soda

dissolved in ten parts of distilled water mixed with one part of alcohol and heated to 150 degrees.

On the completion of the operation, the iodoform $\text{C}_2\text{H}_3\text{I}_3$ crystallizes out and may be separated by the filter, well washed thereon with distilled water, and dried between folds of blotting paper. For its use, see page 73.

Tincture of iodine is made by dissolving one part of the pure crystallized metalloid in ten parts of alcohol. It is exceedingly valuable in restraining the tendency the neutral films and fluids have to fog, and hence to preserve that purity of the shadows, which is so important, especially in the positive process. Its employment in the collodion is much more convenient than adding acid to the bath to the same intent, as it can be exactly regulated, and no more need be mixed than is required, and the eye is enabled to judge of the amount added.

Used in excess it causes an accumulation of nitric acid in the bath; which, perhaps, does no mischief to positives, but certainly will retard the negative. It is therefore better not to work these different collodions in the same bath.

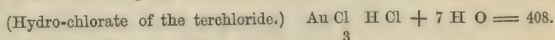
The bromides are all manufactured in a similar manner to the iodides, with the exception of the bromide of ammonium, which may be made direct from its ingredients; but I recommend to amateurs to abstain from meddling with that dangerous substance bromine. Although a dense fluid, it evaporates rapidly at all temperatures, its fumes are excessively irritating to all portions of the human frame, and destructive to all metallic bodies, coloured furniture, &c.

The bromides have the property of diminishing the intensity (hence their value for positives) of collodion when used wet

and developed with pyrogallic, but do not possess this property if the developer be iron; they appear, moreover, to have rather the contrary effect when used in dry processes and on paper.

The chlorides are all found plentifully in commerce and of sufficient purity for our purposes. If pure chloride of sodium cannot be obtained, it is easily made by putting fine salt into a funnel, passing pure water through it until one-fourth is dissolved away, then dissolving the residue, filtering the fluid, evaporating to dryness and heating strongly.

Chloride of gold of commerce is more properly



It is made by dissolving fine (*i.e.* chemically pure) gold in aqua regia (a mixture of three parts by measure of hydrochloric acid and one part nitric acid) and evaporating down the liquid carefully until its golden yellow colour changes slightly to ruby. On cooling it crystallizes in long needles having a very characteristic appearance, and which require to be immediately bottled, as they are exceedingly deliquescent.

Much is said about commercial samples of this article producing evil effects from containing excess of acid, and therefore other compounds, such as the chloride of gold and sodium, &c., are recommended. I do not consider that the latter are equally efficacious in toning, and certainly there is much more danger of the purchaser being defrauded if he departs from the definite compound we have all so long known, which, as shown above, contains very nearly half its weight of the precious metal, and any sample of which may be analyzed by merely heating it to redness and weighing the residue.

KAOLIN (China Clay) is a silicate of alumina, obtained by crushing decomposing granite under a stream of water, which washes out the lighter clay, and deposits it when allowed to rest.

It is produced in enormous quantities in Cornwall, and is used in the manufacture of porcelain, &c. Its employment in photography is due to the affinity it has for colouring matters, which it withdraws from solutions in an insoluble form. If not obtainable from a reliable chemical source, it should be well shaken up with some very dilute acetic acid, well washed and dried before being used.

LITMUS is a preparation from certain lichens. The best is found in commerce in small dark blue $\frac{1}{4}$ inch cubes. The tincture is made by macerating $\frac{1}{4}$ oz. (well pulverized,) in 1 oz. of proof spirit, frequently shaking during a week, then filtering. I have seen it stated in print by those who might have been expected to know better, not only that "litmus paper" is not to be relied on, but that it is very easy to manufacture; two more egregious errors cannot exist. In the first place (like Mrs. Glass) you must "catch your hare:" good litmus is not always to be had, and the tincture will not keep long after being made, so you must make it fresh when you want to make a batch of paper.

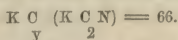
The best for it is good printing "demy," which you immerse a sheet at a time in the tincture. If it does not dry of a bright blue colour, one drop of a solution of potash must be added to the tincture, and this repeated until the desired tint upon the paper is produced. It must be preserved in perfectly closed vessels.

POTASSA (POTASH).

The Hydrate $K O, H O = 57$ —The Metal Potassium $K = 40$.

is obtained by heating the commercial carbonate (salt of tartar) in contact with water and slaked lime, evaporating the liquid to dryness, and fusing the residue.

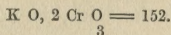
CYANIDE OF POTASSIUM



is rarely required to be pure for our purpose, as in that state it is very expensive; it is produced by dissolving the best commercial cyanide in alcohol and crystallization therefrom.

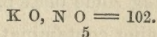
The latter is made by fusing together in an iron crucible eight parts of yellow prussiate of potash (ferro-cyanide of potassium) perfectly free from sulphates and chlorides, and dehydrated, and three parts of the carbonate of potash, equally free from these contaminations and from water. By this process, however, it contains a considerable portion of cyanate, which in no way influences its utility as a fixing agent, except in diminishing its strength. It being desirable to know how much effective cyanide there may be in any sample, I will give the rule for so doing: it is founded upon the fact that an equivalent of silver is thrown down as an insoluble cyanide by an equivalent of cyanide of potassium, and re-dissolved by another equivalent. Thus, if 14.2 grains nitrate of silver are dissolved in one oz. distilled water, and eleven grains pure cyanide of potassium added thereto, the precipitate at first formed will be exactly re-dissolved; any excess of the sample to be tested, required to effect the same result, will give the amount of impurity existing therein.

BICHROMATE OF POTASH



is a salt containing the metal chromium, so called from the great variety of colour exhibited by its salts, and appears destined to play a very important part in future applications of photography, from the remarkable property it possesses of rendering gelatine and other similar bodies insoluble after insolation, and its darkening effect upon the resinous colouring matters of woods, &c. Thus, if a piece of freshly cut mahogany be washed over with a dilute solution of this salt, or the neutral chromate, dried, and exposed to light under a negative, an indelible, very dark-coloured picture will result; the parts not affected may be deprived of the chemical by copious washing with weak solution of carbonate of soda.

NITRATE OF POTASH (NITRE)



may be readily obtained of very great purity by re-crystallizing a good commercial sample even where it cannot be bought pure; it should be free from chlorides and sulphates.

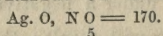
The mode of obtaining pure carbonate and iodide of potassium have been already stated.

PYROXYLINE, see page 17. Since the formula there given was in print, a paper has been read before the Photographic Society, advocating a different mode of preparing this important substance: nevertheless, I see no reason for altering either my formulæ or my directions as to its manufacture, or that of the collodion; I consider, on the contrary, that my formulæ are far better and more likely to produce the article required. The only novelty of any

apparent value is the writer's directions that, previously to being treated with the acids, the cotton should be boiled for two hours in a solution of two ounces caustic potash in a gallon of water, well washed and dried. This may be useful or it may not. I have tried it, and can find no difference in the resulting pyroxyline. I certainly cannot admit that the excess of water and heat recommended are of any advantage; but quite the reverse.

I refer my readers to "The Photographic Journal, No. 95 ;" let them try the experiment, and I think they will agree with my verdict.

NITRATE OF SILVER



This, the most important of photographic chemicals, has been more maligned, in a commercial point of view, than almost any other ; it has been accused by persons interested in recommending some one's particular manufacture, of being acid, or of being contaminated with this and that, or of being knowingly adulterated. My own observations, (and they have been very numerous, and extend over a long series of years,) lead me to form the opinion that no chemical, when obtained from a respectable source, has better maintained its reputation for purity. The analysis is most easily conducted ; $8\frac{1}{2}$ grains, perfectly dry, are dissolved in two oz. pure water, and precipitated by an excess of hydro-chloric acid gas, the liquid boiled until it becomes perfectly bright, and the precipitated chloride washed very carefully and dried very strongly, it should weigh 7.2 grains. The filtrate evaporated to dryness leaves absolutely no residue if the salt be pure.

Nitrate of silver is manufactured, by acting on the pure granulated metal, with pure nitric acid diluted with three

parts of water, evaporating and crystallizing. It should not be fused. If the silver contains copper it still yields pure nitrate if the solution be boiled down to dryness and heated until it fuses, when the copper salt decomposes; a portion of the residue should be tested by dissolving it, filtering, and adding an excess of liquid ammonia, if no blue colour be apparent, all the copper is eliminated. In either instance, the solution should be evaporated to dryness, then re-dissolved in water and tested with litmus paper, to ascertain if there is any basic nitrate produced; if so, this must be decomposed by adding nitric acid q.s., and the liquid evaporated to the crystallizing point. Iodide, bromide, chloride, and acetate of silver being insoluble, are precipitated from a solution of the nitrate on the addition of an equivalent of a suitable iodide, &c.

